STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
FRANK W. DEWOLF, Chief

Cooperative Mining Series

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GAS PURIFICATION IN THE MEDIUM-SIZE GAS PLANTS OF ILLINOIS

BY

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and

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ILLINOIS MINING INVESTIGATIONS

Prepared under a cooperative agreement between the Illinois State Geological Survey Division, the Engineering Experiment Station of the University of Illinois, and the U. S. Bureau of Mines

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GAS PURIFICATION IN THE MEDIUM-SIZE GAS PLANTS OF ILLINOIS

By W. A. Dunkley and C. E. Barnes

PURPOSE OF THE INVESTIGATION

For several years, the Illinois State Geological Survey Division, the Engineering Experiment Station of the University of Illinois, and the U. S. Bureau of Mines have been carrying on a cooperative investigation of coal and coal-mining methods in the central district, which includes the states of Illinois and Indiana, and the western end of Kentucky. One division of the main investigation is the use of coals of this district in gas manufacture. A number of bulletins have been published (see inside rear cover), dealing with various phases of this subject. Gas purification, the topic discussed in the present bulletin, is a phase of the subject which has an important bearing on the use of central district coals in gas manufacture with the existing equipment and operating methods.

One of the chief problems confronting the gas operator in using coals of the central district in place of gas coals from Pennsylvania, West Virginia, and eastern Kentucky, is the increased amount of sulphur which must be removed from the gas before distribution. This increase may be small or large, according to the particular coal used, but even the central district coals of lowest sulphur content usually contain more sulphur and yield more to the unpurified gas, whether coal-gas or water-gas, than do the best low-sulphur gas coals from the regions mentioned, or the cokes made from those coals.

Recognizing this condition, it was decided to make a study of existing purifying conditions in the gas plants in Illinois, to ascertain to what extent the use of low-sulphur central district coals would overload the purifying equipment now installed, and where changes in equipment, operating methods, or purifying materials might be necessary to enable the various plants to purify the gas from central district coals economically, should other conditions make a more extended use of these coals desirable.

Inspection of Gas Plants

The problem of studying Illinois gas-purifying conditions was assigned to W. A. Dunkley, gas engineer of the State Geological Survey Division, and an inspection trip was made by him to sixteen gas plants. The plants visited comprised nearly all of the medium-size plants of the State, including the suburban plants of Chicago. The urban plants of Chicago were not studied at this time, since it was felt that on account of their large size and special conditions, they might have problems which were not typical of individual plants in smaller cities.

NATURE OF DATA COLLECTED

In visiting the various plants an effort was made to secure as detailed information as possible in the time available, regarding load factor, size and arrangement of equipment for cleaning and purifying the gas, gas storage capacity, fuels used, and purifying methods employed. A few simple tests were made in each plant to determine the sulphur content of the unpurified gas and the amount of tar entrained in the gas entering the purifiers. Samples of spent purifying material and unused material were collected wherever possible, in order that information to be gained from chemical analysis of these materials might supplement the information available from inspection of the plants and conversation with the operators. At all stages of the inspection, hearty cooperation was given by the gas men interviewed, and much interest was manifested by them.

With the opening of the college year, 1919-1920, at the University of Illinois, C. E. Barnes, research graduate assistant in gas engineering at the University, was assigned to assist Mr. Dunkley in this study. Mr. Barnes devoted most of his time to the analytical work involved in studying the purifying materials collected during the inspection of the various plants.

A summary of the results of these studies and a statement of the conclusions that seem warranted follow:

SUMMARY

To summarize briefly, the following purifying conditions were found to exist in the plants inspected:

1. Low-sulphur eastern gas coals were being used in practically all of the coal-gas plants inspected. These low-sulphur coals, together with the considerable percentages of water-gas made in most of the plants, gave an average H_2S content in the gas entering the purifiers of only 250 grains per 100 cubic feet.

2. Six of the eight straight water-gas plants inspected were using low-sulphur Illinois or Indiana coals for generator fuel. The average H_2S content in the unpurified gas in the water-gas plants was 140 grains per 100 cubic feet.

3. In spite of the generally low sulphur-content of the gas to be purified in all the plants, 75 per cent of the water-gas plants and 50 per

cent of the mixed-gas plants had maximum hourly gas productions in excess of purifier capacities. The computed overloads varied from 11.5 to 177 per cent.

4. Only two water-gas plants and one mixed-gas plant had average hourly productions in excess of purifying capacity.

5. Overload in most cases was due to lack of uniformity of load on the purifiers. This in turn was due to the sharp peak load and insufficient holder capacity. In some cases the load could probably have been materially reduced by a little more attention to the rate of pumping gas through the purifiers.

6. Tar in appreciable amounts was found in the gas entering the purifiers in nearly all the plants inspected. The spent oxide from all the plants contained some tar. The average tar content of spent oxides from water-gas plants was 6.9 per cent and from mixed-gas plants 3.6 per cent. Tar seemed to be chiefly responsible for low sulphur absorption in some cases.

7. The spent oxides from mixed-gas plants had an average sulphur content of 37.4 per cent, and those from straight water-gas plants had an average sulphur content of 21.7 per cent. Overload and tar seemed to be mainly responsible for these conditions in some cases. In other cases, operating methods seemed to be the cause of these low absorptions.

8. Revivification in place was practiced by most water-gas plants but by few mixed-gas plants at the time of inspection. Only one plant revivified oxide in the off-box. Little trouble was reported in that plant as a result of the practice, and the operating costs were low.

9. Though several purifying installations are arranged for reversible gas flow, there seems to be little effort to realize the fullest advantage from this arrangement. The same is true of rotation of boxes.

10. Few operators keep purifying records from which actual performance of a particular batch of oxide or method of operation can be definitely determined.

11. Few operators make any systematic quantitative tests on their purifiers to determine performance of the individual oxide batches. In several plants where the necessary testing apparatus is available, it is seldom used.

12. It seems that the greatest opportunity for immediate improvement in purifying conditions rests in the establishment of a simple but regular testing routine, together with better purification records. The analysis of fouled oxides for sulphur and tar, even if done by an outside laboratory, would, it is believed, be worth while.

13. Total purification costs for the year 1919 varied in the plants inspected from 0.5 cents to 2.25 cents per 1,000 cubic feet of gas purified. Careful operation and good facilities for the handling of oxide were apparently responsible for low costs in several cases where the equipment was overloaded. Different conditions prevailing in different plants preclude the possibility of drawing comparisons as to the effects of load, etc., on costs.

14. Few different oxides are used in the plants of the State. It is believed that more experimentation on the part of gas companies, to find materials best suited to particular conditions, would be advantageous.

15. The use of low-sulphur Illinois and Indiana coals as water-gas generator fuels is general in the water-gas plants of the State. Though the sulphur content of the resulting unpurified gas is in some cases double that of gas from low-sulphur eastern cokes, the computed capacities of the purifiers is but slightly less in the former case.

16. Low-sulphur Illinois coals in coal-gas manufacture might decrease computed purifier capacities by 25 per cent in some cases, as compared with the gas coals in use at the time of inspection. This decrease might be offset in a measure by more attention to selection of oxides, by making the load on the purifiers as uniform as possible, and by more attention to tar removal and purifying operation.

17. In several cases it appears that coals of higher sulphur content could be handled if existing equipment were rearranged and made more flexible in operation. In a few cases additional purifying apparatus is badly needed.

THE PURIFYING PROCESS

The purification of gas, by which in the narrower sense is meant the removal of the sulphur present in the form of hydrogen sulphide (H_2S), is accomplished by the same process in nearly all the gas plants of the United States. It was discovered about 35 years ago that hydrated oxide of iron was a much more economical absorbent for this sulphur compound than slaked lime which had been in use since the beginning of the gas industry.

Oxide of iron does not remove sulphur compounds other than H_2S present in the gas, but since the gas from most American coals does not usually contain any excessive amount of these other sulphur compounds, it followed that purification with hydrated oxide of iron was adopted almost universally within a few years after its initial use for this purpose. Hydrated oxide of iron, when of good quality, not only absorbs a large amount of hydrogen sulphides, but also, after sulphiding, if exposed to the action of the oxygen of the air, undergoes a process of regeneration whereby iron oxide is again formed by oxidation of a considerable portion of the iron sulphides present, free sulphur being liberated. This process is usually called revivification by gas operators. After revivification the material is again in condition to be used for purifying gas. Alternate sulphiding and revivification may be carried on until, with favorable conditions, the material may contain 50 to 60 per cent of sulphide. It is then usually incapable of absorbing more hydrogen sulphide on account of the clogging action of the free sulphur and the formation of more or less inert iron compounds and is replaced by new material.

The chemical reactions involved in the sulphiding and regenerating, or revivifying, processes are not known with absolute certainty. Various chemical equations have been written expressing the probable final reactions, but it is likely that many secondary reactions really take place which are decidedly more complex than those given in the text books. Since it is the intention to confine this bulletin to the practical working phases of the purifying process, no attempt will be made here to repeat these equations or to go deeply into the theory of the reactions. The reader is referred to the literature of gas manufacture and chemistry for existing information on this subject.

FACTORS AFFECTING PURIFICATION

Efficiency and economy in gas purification depend upon three main factors—equipment, operating methods, and purifying material. The effect of each of these factors is more or less determined by existing plant conditions. Perhaps the most important condition affecting plant conditions is the load factor. Load factor as applied to purification will here be designated as the relation between the volume of gas passing through the purifying equipment during the hour of maximum production and the rated hourly capacity of that equipment, as determined from its dimensions and from practical and theoretical considerations pertaining to operation with the usual purifying materials.

FORMULAS FOR GAS PURIFIERS

Since the advent of the gas industry, nearly 20 formulas have been propounded for the dimensioning of gas purifiers. Many of these were based upon the use of slaked lime, the predecessor of hydrated oxide of iron for purification. Many are indefinite in their terms and include an insufficient number of factors to make them really applicable to present conditions. The formula of the Steere Engineering Company[1] of Detroit, which appeared about a year ago, is perhaps the most complete of all, and while there are still factors which will probably have to be introduced or changed in it when our knowledge of these factors becomes more complete, the formula is very useful and has been used in the computations of this bulletin. For the convenience of readers, the Steere formula and some information regarding its use are given in Appendix A.

DESIGN OF EQUIPMENT

In designing purifying equipment for a given plant, a number of things must be considered. One of the most important is the output of the plant, both present and prospective. In spite of electric competition, the output of most gas plants is growing rapidly; in fact, many companies are experiencing difficulty in keeping up with the demand for gas. It is important, therefore, to make the purifying equipment of ample size, but at the same time the investment is heavy and the interest on a greatly oversized equipment may offset to a considerable extent the operating advantages which might be derived from extra large capacity.

LOAD FACTOR

Another factor to be considered is the distribution of load during the day. The rate of output of most plants is far from uniform. Indeed, it is not unusual for some plants to put out 10 per cent of their daily production during the hour of maximum load. And since storage capacity has not usually grown apace with output, it is frequently necessary to generate and purify the gas practically as fast as it is sent out. From the figures

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[1] Gas Age, Vol. 43, p. 227, 1919.

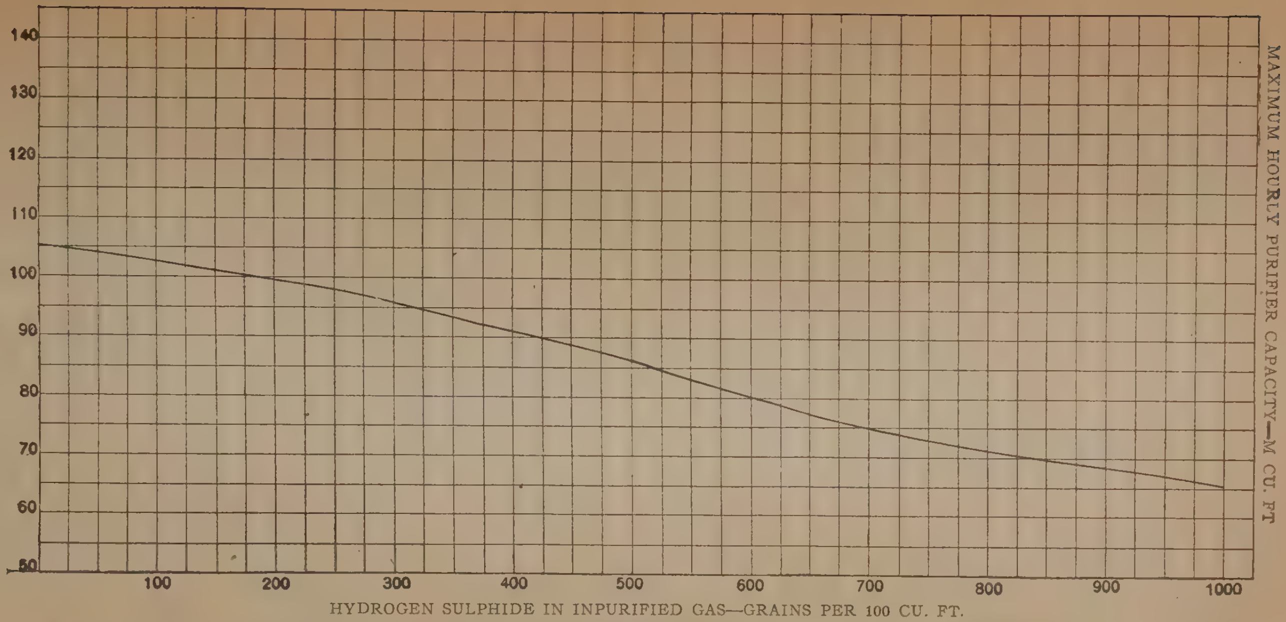

Figure 1—Effect of hydrogen sulphide content of unpurified gas on purifier capacity, in a plant having purifiers rated at 100,000 cu. ft. hourly capacity with gas containing 200 grains of hydrogen sulphide per 100 cu. ft.

obtained from the inspection of 16 gas plants of Illinois, of which 8 made straight water-gas and 8 mixed coal- and water-gas, it was found that the maximum volume of gas purified per hour in water-gas plants varied from 4.5 per cent to 11.2 per cent of the maximum daily output, with an average of 7 per cent; and in mixed-gas plants from 3.6 per cent to 9.3 per cent, with an average of about 6 per cent. Since the complete absorption of hydrogen sulphide from the gas by iron oxide takes a measurable time, the purifiers must be so designed that even at maximum rate of flow there will be ample time of contact between gas and oxide, even when the oxide is partially sulphided and inactive. As the laws of nearly every state require that the gas leaving the gas plant must at all times be free from any appreciable amount of hydrogen sulphide, the gas manufacturer must comply with this requirement by whatever means he may. Oftentimes when the purifying equipment is heavily overloaded or fuels run considerably higher in sulphur content that usual, compliance with the law is difficult and costly!

As an economic matter, the purifiers must be so designed that they will hold enough oxide to completely purify the gas at the maximum rate of flow for a sufficient time so that it will not be necessary to handle the oxide too frequently. It is desirable that the oxide be allowed to remain in the purifiers long enough between revivifications so that it will absorb a reasonable amount of sulphur. The labor cost of handling oxide is one of the heaviest items of purification cost, and it is therefore desirable that an oxide take up a maximum amount of sulphur with the least cost of handling. This can be done by making the purifiers large enough, due consideration being given to investment charges.

SULPHUR CONTENT OF GAS

The sulphur content of the gas to be purified is another factor to be considered. The gas industry has always been a particular customer in the purchase of coal, and the sulphur content has always been an important specification where there was otherwise little choice between coals. Good gas coals heretofore have contained not exceeding one per cent of total sulphur, and frequently the content of sulphur has been only .5 or .6 of one per cent. The decrease in supply of such superfine coals has caused gas operators to look about for possible new supplies, but while the industry will probably have to be reasonably particular so long as present purifying methods are in use, it will probably be necessary to use coals of higher sulphur content than would heretofore have been considered expedient. In water-gas not only the sulphur content of the generator fuel, but also the sulphur in the enriching oil must be considered. Purifying equipment consequently will have to be designed with these matters in mind.

The maximum permissible rate of gas flow through a system of purifiers does not vary inversely as the hydrogen sulphide content of the gas to be purified. Figure 1, which is plotted from the Steere formula, shows the relation existing between maximum hourly rate of gas flow through the purifiers and the hydrogen sulphide content of the gas. The curve represents the maximum hourly purifying capacity with various contents of hydrogen sulphide of a plant which would have a capacity of 100,000 cubic feet of gas per hour, if the gas to be purified contained 200 grains of hydrogen sulphide per 100 cubic feet.[1] It will be noted that if the sulphur content is multiplied by 5, giving 1,000 grains per 100 cubic feet, the capacity is reduced from 100,000 cubic feet to 66,500 cubic feet. Capacity in this sense pertains, of course, to the hourly rate of gas flow permissible, not to the capacity of the oxide for absorbing H_2S. If the oxide in the purifiers could be completely fouled in either case, it is evident that five times as much gas containing 200 grains of H_2S could be purified. It is evident, therefore, that the permissible rate of gas flow through the purifiers is not directly proportional to the absorption capacity of the oxide nor inversely proportional to the sulphur content of the gas. The rate of the chemical reaction has an important bearing, but this is not taken directly into consideration in any existing formula for the design of purifiers, though it is indirectly allowed for in the Steere formula.

CAPACITY OF AUXILIARY EQUIPMENT

While the capacity of the oxide purifiers must be designed to handle the maximum hourly load, a properly designed system may fail to accomplish the complete purification of the gas because of conditions existing in other units of the gas-cleaning apparatus. Under favorable operating conditions, the purifiers are not usually called upon to handle all of the hydrogen sulphide that is originally present in the gas when generated. Water and tar vapor condensing from the gas in the condensers, and wash water in the scrubbers all remove a certain amount of H_2S from the gas. In coal-gas plants the ammonia present in the gas has a very important part in sulphur removal, since it combines directly with H_2S. There is not enough ammonia present to remove all the sulphur, but this incidental purification may remove as much as 20 per cent to 40 per cent of the H_2S present in the gas. If the condensing and scrubbing apparatus is under-

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[1] It may be objected by some that when the gas contains no H_2S at all the capacity of the purifiers would be infinite and that there should be concomitantly a sharp rise in the curve. Practically, however, as soon as there is any appreciable amount of H_2S present in the gas, the time factor of the reaction between H_2S and hydrated oxide of iron comes into play, necessitating a very appreciable time of contact to purify the gas. It is often observed in practice that it is more difficult to remove the last 10 per cent of H_2S from the gas than the first 90 per cent, emphasizing the fact that the permissible rate of purification is not inversely proportional to the H_2S content of the gas.

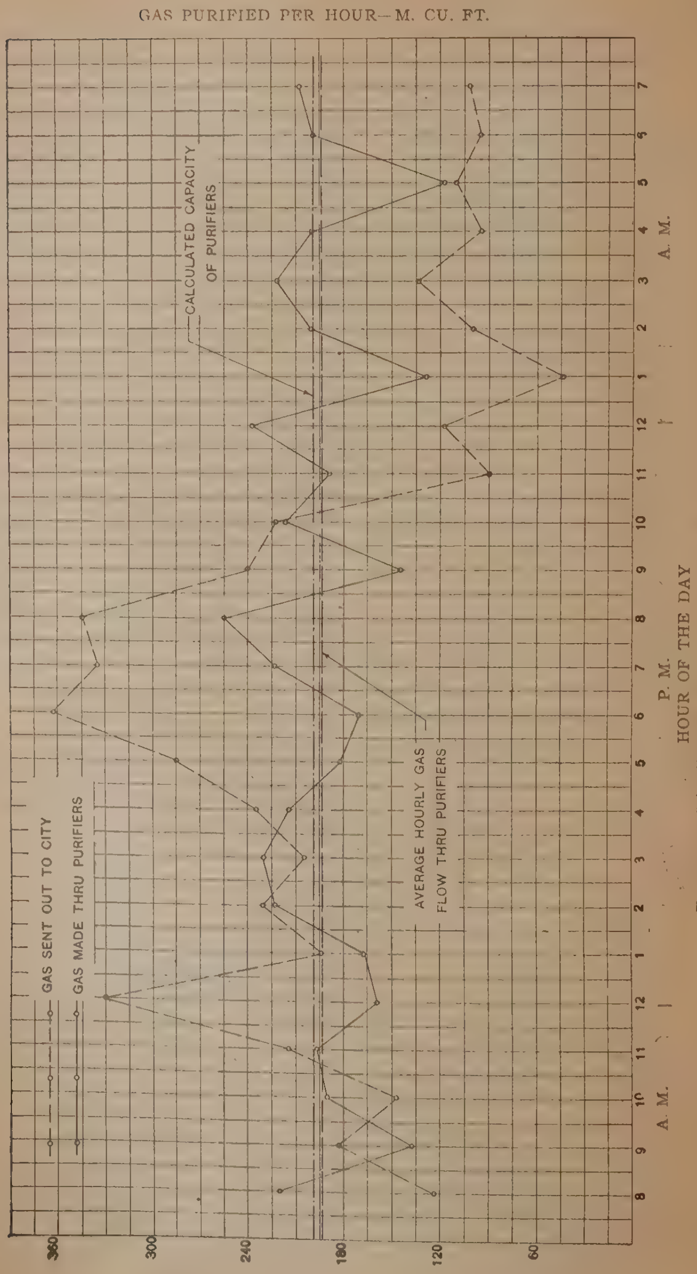

FIGURE 2.—Distribution of load in a typical water-gas plant

sized, not only is this incidental purification diminished, but the oxide purifiers are forced to do part of the work, namely, tar extraction, which should-be confined to the first-mentioned equipment. Tar and oil vapors undoubtedly have a detrimental effect on the operation of the purifiers. since they coat the purifying material and render it partly inactive. Despite the recognized harmful effect of these vapors, there are few plants in which the gas entering the purifiers is entirely free from them. In some plants well equipped as to purifier capacity this condition is responsible for poor purifying results. Tar removal before purification is very important both as a matter of equipment design and of operation, and deserves more attention than it usually gets. Some kind of test by which the tar content of the gas entering the purifiers can be determined, should be made regularly where purifying results indicate the possibility of this trouble. Frequently a plant which seems to need additional purifying capacity is really in far greater need of more efficient tar-extracting apparatus.

PURIFIER OPERATION

UNIFORMITY OF LOAD

Granted adequate purifying equipment, the purifying efficiencies realized will depend much upon how the equipment is operated. First, the handling of the load may well be considered. The hourly rate of gas output from a plant is, of course, out of the control of the gas manufacturer. He must supply the demand as needed. For the sake of safety to tide over any accident to the gas-producing equipment, it is usually considered necessary to keep the gas storage holders as nearly full as possible at all times. If the storage capacity is much undersize, in order to make good the output, it may be necessary to purify the gas almost at the rate of output during certain hours of the day. This may necessitate purifying the gas at a rate much in excess of the rated purifying capacity during such times. Even so, it may be possible by attention to smooth out the production curve somewhat. Figure 2 shows the output and production rates in a typical water-gas plant operating 24 hours per day. The rated capacity of the purifiers and the average hourly make are shown by horizontal lines. It will be noted that the hours of large production do not always coincide with the hours of large output. The production curve crosses and recrosses the line of average production not only when the production is near the average for a considerable time, but also when it is averaging considerably above or below the general average for some time. By careful attention to the rate of pumping gas these wide fluctuations could probably be prevented to a considerable extent with benefit to purifying operation.

TEMPERATURE CONTROL

Temperature control is another important consideration in purifier operation. Both excessively high and excessively low temperatures at the purifiers should be avoided. The statement is often made that at low temperatures (below about 60° F.) the sulphiding reaction becomes sluggish. That there is some difference of opinion relative to the effect of temperature on the purifying process, is indicated by the fact that this matter is now being studied by the Purification Committee of the American Gas Association. A temperature of about 100° F. is usually thought to give the best results, and often it is considered important that the temperature be kept up in winter by artificial means if necessary. Formerly it was the practice to have the purifiers installed indoors, but the high cost of building construction as well as successful experiments with outdoor purifiers have resulted in a rapidly increasing number of outdoor installations. Practically all of the new installations are of the latter type. Where the temperature of the gas has a tendency to fall in winter much below the temperatures above stated, it can usually be kept up by the installation of steam coils in the purifiers or by injection of steam into the gas ahead of the purifiers. The latter practice may be questioned by some operators on account of the amount of moisture which is deposited in the purifying material, while the former may be open to objection on the ground that it dries out the oxide too much. Some outdoor installations are insulated to diminish the drop in temperature during cold weather, but this is not common practice, at least in Illinois.

While a fairly high temperature is usually considered advantageous in its effect on the sulphiding reaction, the temperature of the gas throughout the condensing and purifying system should not be maintained too high, lest difficulty be experienced in extracting the tar. A temperature much above 100° at the inlet to the purifiers, if maintained by the original heat in the gas as generated, would usually necessitate a temperature considerably in excess of this back at the tar-extracting equipment. It is usually considered that 100° to 110° F. is about the highest temperature at which tar can be extracted efficiently by most forms of tar extractors, though opinion may vary on this point. During the inspection trip to various Illinois plants by the writer, several cases were observed where the temperature at the inlet of the purifiers was around 120° to 130°, but in practically every such instance there was an excessive amount of tar being carried into the purifiers. Probably the best results will be obtained by maintaining a temperature of 90° to 100° F. at the boxes and keeping the gas saturated with water by the admission of steam to the gas, or otherwise.

REVIVIFICATION

OUTDOOR REVIVIFICATION

As previously mentioned, the greatest advantage of hydrated oxide of iron as an absorbent for hydrogen sulphide lies in its ability to revivify or regenerate when after sulphiding it is exposed to the oxygen of the air. Naturally the first method of revivification adopted was to remove the sulphided material from the purifying box and expose it to the air. The appearance of the material as it changes from the black iron sulphide to red or brown iron oxide, is of course a guide to the operator by which he can determine with more or less certainty when the material is reoxidized and ready for use in the purifiers again. The usual procedure in revivifying out of doors is to put the material in piles or windrows, perhaps two or three feet high. When the material begins to heat as a result of the oxidation process, it is raked down into a layer a foot or so in thickness, and as the surface reddens, the whole mass is turned over by shovel, this operation being repeated until the mass is of uniform color and no longer heats. This process, simple as it seems, requires considerable attention. The material frequently oxidizes very rapidly upon removal from the purifiers, and when it contains a considerable percentage of iron sulphide it is likely to ignite, especially if in a deep mass from which heat cannot escape readily. Overheating is detrimental to the further value of the material, rendering it inactive. At the same time, a moderate degree of heat promotes the oxidizing reaction without injuring the material. The operator therefore usually cools hot spots in the material by shoveling them out and exposing the hot material to the open air, which rapidly cools it, rather than by application of water, which cools the material to such an extent as to unduly retard the revivification.

This method of revivification involves much handling of the material. Indeed, since it is not possible to leave material in the boxes until it is completely sulphided, it is usually necessary to handle it a dozen times or more to get a very good sulphide content. But since the sulphiding and revivifying reactions slow down greatly after a time, the cost of handling the material may soon offset the value of the work it is doing. Consequently, material is frequently discarded long before it contains 50 to 60 per cent sulphur, which is considered good operation.

REVIVIFICATION IN PLACE

Naturally gas operators looked for a method of revivifying which involved less handling of oxide, and revivification in place was the outcome. Two methods are in use at the present time, namely, (1) introduction of a small percentage of air (1 to 2 per cent) into the gas ahead of the purifiers; (2) blowing or drawing air through a box of material which has been shut off from the remainder of the purifying system. Each of these methods of revivification has its advantages and disadvantages, and there are some details of operation in both cases on which operators disagree.

SMALL PERCENTAGE OF AIR WITH THE GAS

One advantage of the first method is that it involves no danger and requires little attention. The air pump is connected to the exhauster and pumps more or less air as the exhauster runs faster or slower. One obvious disadvantage of the first method is the amount of inert nitrogen which is introduced into the gas, if an attempt is made to introduce enough air to secure complete revivification in place. Although less than 0.5 per cent of air would theoretically be required to accomplish the revivification of an oxide which was being fouled with gas containing, say, 100 grains of H_2S per 100 cubic feet, as a matter of fact, even 2 per cent does not completely accomplish revivification. Excessive nitrogen of course dilutes the gas and requires additional enrichment, especially if the gas is made to conform to a candle-power standard. With the heating-value standard which is fortunately rapidly replacing the candle-power standard, this effect is not so serious. The differences in operation found in different plants with this method of revivification relate chiefly to the reversal of direction of gas flow and order of the purifiers with respect to the condition of the contained materials. These will be discussed in the next section.

AIR BLOWN THROUGH OXIDE IN AN OFF-BOX

Revivification by forcing air through a box of oxide after shutting off the gas has been employed in various plants for a number of years and is heartily approved by many operators, and as heartily condemned by others. Its advantage lies in the fact that no nitrogen is admitted to the gas. On the other hand, careful attention has to be given to it while in progress, and under some circumstances it may be dangerous. O. B. Evans[1] of Philadelphia presented a paper before the American Gas Association recently, in which the experiences of several companies in the use of this method are given. From these experiences he concludes that revivification by this method is a simple operation when purifying capacity is ample and revivifications are frequent, but with overloaded purifiers extreme care must be used to prevent firing of the oxide. He believes that the best method is to recirculate air (which soon becomes chiefly nitrogen, since the oxygen is soon removed by the purifying material) continuously through the box and through a cooler of the contact type, in which it comes in contact with water. The water keeps the recirculated mixture saturated, and the water vapor helps to keep down the temperature in the oxide. Arrangement of valves is made whereby a small amount of fresh air can be admitted to the circulation and a similar amount of inert gas expelled from it as desired. The blower should be of sufficient capacity to reduce channeling effect and to circulate the mixture faster than the rate at which gas is passed through the box during operation. He states that shallow boxes aid considerably in successful revivification in place on account of their greater radiating capacity per bushel of oxide. With these methods Mr. Evans believes that revivification can be carried out without danger, channeling and excessive local heating being largely avoided. The successful experiences of many operators over a number of years confirm this.

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[1] O. B. Evans, Revivification in place, presented at a meeting of the Amer. Gas Assn., October, 1919.

REVERSAL OF GAS FLOW AND ROTATION OF BOXES

Reversal of direction of gas flow through the purifiers and the order of the various purifiers with respect to the condition of the contained oxide, are matters of considerable importance in connection with revivification in place. In both of these matters the operator may be limited by the arrangement of his equipment. Not all plants are so arranged that the direction of gas flow in a given box can be reversed; and while a certain amount of latitude is usually allowed as to the order of purifying boxes, one finds a number of cases where the connections are so arranged that the possible number of combinations is small. Obviously, any group of purifiers must be so connected that any box can be shut off for refilling. In most of the older installations, when one box is off, the order of the other boxes is predetermined, only one arrangement being possible. Reversal and rotation, as applied to revivification in place, depend upon the principle pointed out several years ago by B. E. Chollar, that iron sulphide will not revivify to the oxide in the presence of hydrogen sulphide. Let us assume, as is frequently the case in new purifier installations, that the gas enters at the middle of the box and passes downward and upward through the two layers of oxide and comes out at the top and bottom of the box. The lower layer will sulphide downward and the upper layer upward. If when the sulphiding has extended say half-way through each layer, the direction of flow be reversed so that the gas enters at the top and bottom of the box and leaves at the middle, then the comparatively fresh oxide in the top of the upper layer and the bottom of the lower layer will remove the H_2S from the gas, and any oxygen present will go on and revivify the foul upper part of the lower layer and the lower part of the upper layer. The frequency of reversals will depend upon the degree of loading of the purifiers. Where the purifiers are being operated at normal capacity, reversal once a week is often advised. With an overload, it might be advisable to to reverse oftener.

Box rotation is another means to accomplish the same end. Where there are three or more boxes in series, it would seem logical to have the clean box first to remove the H_2S and the fouler boxes after, to be revivified by the oxygen which had been admitted to the gas. The following are suggested orders of rotation of a 4-box set, the changes being made when H_2S appears at the outlet of the third box:

1 — 2 — 3 — 4
4 — 1 — 2 — 3
3 — 4 — 1 — 2
2 — 3 — 4 — 1

In this way the most revivified batch is placed first and the next cleanest batch is always last to take up any traces of H_2S which may get by the previous batches at any time.

Where there are only two boxes in series, especially those of the non-reversing type, it would hardly seem advisable to have the clean box first, since failure of the second box to revivify for any reason would leave no active material to intercept traces of hydrogen sulphide.

As stated earlier in this section, there is no method of procedure in the matter of revivification in place, which is accepted as best practice by all operators. The only way by which any operator may arrive at a satisfactory conclusion is to try various methods and arrangements and satisfy himself which method is most applicable to his particular plant.

CHEMICAL CONTROL AND RECORDS

In order to secure and maintain good purifying efficiencies, it is important that the operator know at all times the status of the material in each one of his purifiers. Knowing this, he will not only be able to judge whether his method of operation is satisfactory, but he will be able to detect differences in purifying material which might otherwise be obscured by other conditions. The extent of the system of tests and records maintained will of course depend, among other things, upon size of the plant and the force available. Practically every plant makes the simple lead acetate paper test, but this is merely qualitative. It tells of the presence or absence of hydrogen sulphide, but gives little information relative to the amount present. The total-sulphur test carried on under the requirements of the Public Utilities Commission, at least in the State of Illinois, gives information only with respect to the amount of sulphur in all forms present in the finshed gas, but gives no information in regard to the performance of the individual purifiers.

The introduction several years ago of the Tutwiler hydrogen sulphide burette marked a distinct advance in the matter of checking up purifier operation because it gave the gas operator a simple, easy method of studying his purifier performance without the aid of a trained chemist. Unfortunately, the apparatus has to be made of glass, and is so shaped and proportioned that it is easily broken; and, further, unless care is taken to remove the plugs of the glass stop-cocks and insert pieces of paper around them after using, they are very liable to become hopelessly stuck in a short time. Nevertheless, with reasonable care the apparatus can be kept in good order, and the information obtained with it is very useful. One advantage of the instrument is the short time required to make a series of determinations. Probably after a very little practice any operator, even with no chemical training whatsoever, could make a test of the gas entering the first box and leaving each box of a four-box series, in fifteen or twenty minutes. By simple subtraction of the number of grains of hydrogen sulphide found at the outlet of each box from the amount present at the inlet the amount of sulphur being removed by each box would be immediately known. The results of a test on a certain day might be as follows:

		H_2S Removed
Grains H_2S before boxes	100	
“ “ after 1st box	25	75 by 1st box
“ “ “ 2d “	10	15 “ 2d “
“ “ “ 3d “	5	5 “ 3d “
“ “ “ 4th “	0	5 “ 4th “

Now 5 grains of H_2S after the third box could probably be detected by lead acetate paper as ordinarily used and would perhaps ordinarily be taken as a sign to change the order or empty a box, but if this same distribution of the work continued for several days and the last box handled the remaining few grains of H_2S were absorbed in the last box all right it might be well to retain this order for a time, since a larger absorption in the first box would be accumulating. A considerably greater sulphur absorption might be realized in the first box than would be obtained if it were emptied or reversed as soon as a trace, as shown by lead acetate paper, was visible at the outlet of the third box. Steere[1] states that 20 to 50 grains of H_2S may be safely passed to the last box if tests are made regularly, and the boxes are properly proportioned. He would allow 20 additional grains to pass to the last regular box, where a catch box is provided. On the other hand, let us assume that the following results were shown by the tests:

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[1] Bull 37, Steere Engineering Co., 1919.

		H_2S Removed
Grains H_2S before boxes	100	
" " " 1st box	80	20 by 1st box
" " " 2d "	20	60 " 2d "
" " " 3d "	5	15 " 3d "
" " " 4th "	0	5 " 4th "

It would at once be evident that box No. 1 was not doing its share of the work, since if it were in good condition it could usually be expected to do at least 60 per cent of the total absorption. It would be evident that box No. 2 was bearing the chief burden and it would be high time to empty No. 1 or reverse so that it would clear up.

If such tests as the above were made faithfully day after day and carefully recorded in a book (not on loose scraps of paper) it is evident that a running record could be maintained from which, knowing the amount of gas metered per day, the actual number of grains of H_2S absorbed by each box from change to change would be known. Knowing the number of bushels of oxide in each box, the volume of gas passing in a given time, and the number of grains of H_2S absorbed by each box per 100 cubic feet of gas passing through, it would be very simple to calculate with a reasonable degree of accuracy the number of pounds of sulphur absorbed per bushel. A sample record and computation is given in Appendix B. Such results would be of far greater value in determining relative merits of various operating methods or of various oxides than would the usual record of gas purified per bushel between changes, because unless tests are made there is no way of knowing what proportion of the purification should be credited to each box. Usually the first box is credited with all of the purification on the theory that in the long run each box will be similarly credited, and will average up, but during this same time the sulphur content of the gas may change, or more or less tar may be carried forward, affecting sulphur absorption so that the actual performance may be entirely obscured by other conditions.

As a final check on operation, analysis of the oxide for suphur and tar after each removal from the box and especially before discard would be very helpful. Often a batch of oxide is discarded when it is still capable of doing much useful work, and perhaps even more often a batch is returned to the box at considerable expense of handling when it might better have been discarded. Even the trained eye may sometimes be deceived in judging oxide, especially if it contains some tar. In a paper by Fulweiler and Kunberger[1] a method for determining mathematically whether a given batch of oxide is worth using again has been developed. The formula used is given in Appendix C. It will be observed that no knowledge of higher mathematics is required, though one does need to know what the batch has done in the past and what it is capable of doing as judged by a simple laboratory test. If the operator were in possession of the facts derived from the running record of tests above described, together with certain costs which he should know for intelligent operation of his plant, it would not be difficult to use the formula provided he could make or have made an analysis of his oxide and a laboratory hydrogen sulphide absorption test.

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[1] Some of the Physical Characteristics of Ferric Oxide, Proc., Amer. Gas Institute, 1913, Vol. 8, Pt. 1, p. 476.

The writers of this paper do not advise every gas company large and small, to maintain a chemical laboratory and a trained chemist. The small companies probably could not afford these refinements. The large companies already have them and know their value. We will not attempt to prescribe the minimum size of plant that can afford a laboratory. However, many of the smaller plants in this and other states are links in a chain of plants. It would seem feasible for a chain of several plants to maintain a laboratory and a chemist, to whom samples of oxide, ammonia, and other materials could be sent for examination. The results reported by him from testing oxides, together with the Tutwiler test made by the plant superintendent or other person, and adequate record of purifier changes and batch performance, all taken together, would suffice to put purifying operation on a much higher plane than it now is in the average plant. It is believed that it would also effect a real economy in dollars and cents within a reasonable time.

Purification costs heretofore have usually been but a small item in the total cost of making and distributing gas, but with the greatly increased cost of labor, it is becoming especially desirable to get the greatest absorption of sulphur with the least amount of handling. Revivification in place, with its obvious advantages where properly conducted, should become much more general. If difficulties are encountered, careful inquiries should be made as to why they are encountered. Only by intelligent study, aided by tests and good records, can the best results be obtained.

QUALITY OF OXIDE FOR GAS PURIFICATION

The quality of oxide used for purifying gas is another factor affecting efficiency and economy of purification, but this has not as yet been worked out so that it can be expressed mathematically in computing performance of a given equipment. Some research work, having as its object the determination of the effects of the peculiar properties of various oxides is now in progress, and it is hoped to throw some light on the subject in a later publication. At the present time it is recognized that oxides produced by different processes, and indeed even oxides made by the same process, show variations in performance, but just what are the causes of these variations and how they can be controlled is not now known.

TYPES OF HYDRATED IRON OXIDES

Three main types of hydrated oxide of iron are in use for purification. These include:

(1) Oxides made by rusting case iron borings in the air with water only, or with accelerating agents such as sulphate of iron, salt, etc.

(2) Natural oxides, which include certain ores having the proper chemical and physical condition.

(3) Precipitated oxides, made by the chemical precipitation of hydrated oxides of iron from the salts of iron produced as by-products in certain industries or from the iron-bearing water of some mines.

Each of these oxides has properties peculiar to itself, the reasons for which are not yet clear. While ferric oxide (Fe_2O_3) is included in the composition of each and is the reacting material, the presence of other materials in combination with it and the physical structure of the material are of the greatest importance in determining performance. Ferric oxide by itself without water of hydration is almost or entirely non-reactive with hydrogen sulphide.

Formerly the iron content of a commercial material was considered as an index to its value for purifying gas. While this may be true to a limited degree when applied to oxides of one type, it does not hold in comparing oxides of different types.

TESTS OF OXIDES

Since the absorption of hydrogen sulphide is the main thing desired from the oxide, it follows that tests which will indicate the absorbing value of a particular oxide are the most logical ones to apply in valuing a material. Such tests have been devised but no test which has yet been suggested is sufficiently definite in its provisions and indicative of the results to be obtained in actual practice to thoroughly meet the requirements of a standard test. This is evidenced by the fact that the Purification Committee of the American Gas Association is now endeavoring to devise such a standard test, which will meet the requirements of the gas industry generally.

One of the simplest and best-known laboratory tests worked out thus far is that of A. F. Kunberger[1] (see Appendix C). In the Kunberger method a small weighed sample of oxide is fouled by dry hydrogen sulphide for one hour, the water liberated by the reaction being retained in a tube containing granulated fused calcium chloride, which is weighed with the tube containing the oxide before and after fouling. The gain in weight of the two tubes (or one tube containing both oxide and calcium chloride may be used) is equal to the weight of H_2S absorbed.

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[1] Some of the Physical Characteristics of Ferric Oxide: Proc., Amer. Gas Institute, 1913,

Such a test is very useful in determining the relative capacities of various materials under the conditions of the test. The test is also said by some operators to check practical operations quite closely. Other operators, however, place less reliance in it, and in purchasing an oxide of unknown quality are not satisfied with anything less than a semi-commercial test. Such a test usually consists in fouling two oxides, one of known practical performance, the other the unknown material, with unpurified gas, in a pair of small purifiers. These purifiers may contain from a few quarts to a few bushels of the materials in one or more layers. Sometimes two sets of two or more purifiers each are used. The purifiers are followed by gas meters to measure the gas passing through each oxide. The test usually consists in passing gas through both materials at the same rate and noting the volume of gas purified by each until the time when some hydrogen sulphide passes one material as shown by a test with lead acetate paper at the outlet. The rate of gas flow at the beginning of the test is generally at least twice that usual in practice. Sometimes when one material begins to pass hydrogen sulphide the rate of flow is reduced until absorption is complete and the test continued at the new rate until H_2S again passes the material. The test may be continued until both materials are entirely fouled and in some cases the materials after revivification are tested again. Such a test would seem to possess advantages over a strictly laboratory test, since the same kind of gas is used that has to be purified in the works purifiers and the rate of fouling is nearer to that obtaining in practice. On the other hand, in small test installations where the surface of contact between the oxide and the box is usually relatively much greater than in practice, there is danger of the gas passing up the sides of the box to a considerable extent and the excessive rates of purification are likely to cause channelling. Another disadvantage of tests of this kind is the time required to complete them. With rates of fouling approaching those in practice, weeks or even months may be required to foul the materials.

In all tests of oxides, the great difficulty is to interpret the results fairly and with certainty. At present those gas companies who make extensive tests on oxides interpret the tests as best they can in accordance with their own particular conditions and the opinions of their own engineers, and until a standard test with carefully specified equipment and testing procedure is worked out, it will be very difficult properly to evaluate commercial purifying materials.

ACTIVITY AND CAPACITY OF OXIDES

The existing overloaded condition of the purifying apparatus in many gas plants necessitates more attention to the activity or speed of oxides than has hitherto been given to the subject. A satisfactory test must indicate the relative activity of the materials under test. At the same time capacity of oxides will remain an important consideration. The Steere formula allows about 6 minutes time of contact of gas with oxide, assuming all the space occupied by the oxide to be free space. The actual free space in a layer of oxide will of course be considerably less than the total volume, depending upon the coarseness of the material, a factor which is continually changing as the material is used and becomes more and more clogged with sulphur. A new oxide sponge might have 60 to 70 per cent free space, and therefore the actual item of contact would be considerably less than 6 minutes as mentioned above. If, as is sometimes the case, the time of contact in a heavily loaded purifying system is reduced to 2 minutes or less, it is evident that the rapidity of the material may have a very important bearing on its value for such a plant. It is quite likely that various factors could be worked out applying to various types of purifying oxides, which introduced into formulas for purifying capacities would materially alter the hourly capacities permissible with an equipment of a given size and arrangement. This subject needs further study. For the present the differences in oxides will not be considered in studying the purifying conditions in Illinois plants. Computations will be made, assuming that all oxides are the same. In drawing conclusions and suggesting remedies for certain cases, the possibility of using more rapid oxides must be borne in mind.

CONDITIONS FOUND IN ILLINOIS PLANTS

Having considered the conditions affecting purifying efficiencies, let us see what the actual conditions are in Illinois plants, so far as can be determined from the information collected.

As was mentioned earlier in this bulletin, sixteen of the medium-size plants of the State were visited. Information was gathered relative to load conditions, size and kind of equipment, operating methods, and to a certain extent, the results obtained. This latter information was supplemented by the results of analyses of spent oxide samples collected in the various plants.

Upon returning to headquarters the information obtained was tabulated, purifier capacities were computed, oxide samples were analyzed, and the results tabulated. Half of the plants visited were mixed-gas plants. Their problems were somewhat different from those of straight water-gas plants, so the data and results have been tabulated separately. In accordance with an oral agreement under which results were obtained, the tabulations contain no plant names. The writers will be glad to inform any operator as to the designation of his own plant, in order that explanations may be made in case of misunderstanding or difference of opinion as to results obtained.

EQUIPMENT CONDITIONS

The purifying equipment conditions in Illinois plants are probably the same as those existing in similar plants elsewhere. There is the usual combination of old and new equipment which results from piecemeal construction. The old equipment has often been outgrown, but in many cases is still serviceable, and the usual policy has been to increase capacity by adding another purifier, usually of the outdoor type, to the older indoor equipment, retaining the latter in service. Such a condition exists in about half of the plants inspected.

While it is of course advantageous to get as much economical service as possible from a given unit of equipment, it appears in some cases that the old equipment is a drag on the new. In making additions in some cases, the minimum cost of the addition has been looked after, rather than operating economy. The connections are so arranged as to permit both the old and new equipment to be used at the same time, but with little regard to the flexibility of the system. The arrangement is often so fixed as to permit only one order of the boxes in series. In some cases there is a certain latitude for arrangement among the old units, but usually the new equipment either precedes or follows the old in a fixed position relative to it. Most of the new purifiers are equipped for deep layers of oxide and valved for reversible flow, whereas most of the old boxes have shallow oxide layers and straight flow. In no case which we recall is there a combination of old and new equipment in use, provided with arrangements for perfect flexibility as to rotation of boxes and reversibility of flow. In about half the plants are the boxes uniform as to size and type and completely flexible as to arrangement.

The computation of purifier capacity for many of the plants is a rather complicated matter. The Steere formula is applicable primarily to boxes arranged for reversible flow, though the formula can be applied to straight-flow boxes by the use of an appropriate factor. In some plants where there is a combination of reversible and straight-flow boxes, it is necessary to use one's judgment in the selection of the proper factor, and opinions of two engineers might differ as to the proper value of the factor to be taken.

PURIFYING EQUIPMENT OF INDIVIDUAL PLANTS

The following is a brief description of the purifying equipment of the various plants inspected, together with remarks relative to special conditions which seem noteworthy and pertinent.

Plant No. 1. The purifying equipment of this straight water-gas plant consists of three cylindrical steel outdoor boxes, each 35 feet in diameter and 13 feet high. Each box contains two layers of oxide 4 feet deep. The arrangement is entirely flexible, permitting the boxes to be used in any desired order. The direction of gas flow in each box is reversible, the gas entering between the layers and leaving at the top and bottom or vice versa. Southern Illinois coal is used as generator fuel in this plant and the gas at the purifier inlet contained 180 grains of H_2S per 100 cubic feet at time of inspection. The computed hourly capacity of the purifiers is 240,000 cubic feet, or nearly 2.2 times the maximum hourly make reported. The installation is therefore oversize and with good oxide would permit the use of coal of considerably higher sulphide content, if other conditions made it desirable. The cost of purification per thousand cubic feet in this plant should be very low, unless the capital charges on an equipment so considerably oversize are excessive. No figures relative to capital charges are available. Analyses of spent oxide from this plant indicate that best results are not being realized from this equipment, the sulphur absorption per bushel not being nearly so high as in several other water-gas plants that are much more heavily loaded.

Plant No. 2. The purifying equipment in this plant consists of two cylindrical dry-seal straight-flow indoor boxes, 18 feet in diameter and 9 feet deep. Each box contains two 4-foot 3-inch layers of oxide. The generator fuel used at time of inspection was eastern coke and the H_2S content of the unpurified gas was 100 grains per 100 cubic feet. The computed hourly capacity of the boxes was 39,800 cubic feet of gas, which could theoretically be increased to about 52,000 cubic feet per hour by arranging for reversible flow, while the maximum hourly make was reported as 110,000 cubic feet. The sulphur absorption per bushel in this plant was low, as would be expected in a plant so overloaded. The situation was complicated by insufficient condensing apparatus and by a relief holder having but one connection, giving but slight opportunity for any cooling of gas in the holder. At the time of inspection the gas was entering the boxes at a temperature of about 120°F. and was carrying much tar fog. Analyses of spent oxide, however, indicate that this is not a year-around condition. The purifying condition in this plant were the most unfavorable observed in the State, and it is greatly to the credit of the operators that they succeeded so well in supplying clean gas to the public. The shortcomings of the present cleaning and purifying systems are realized by the management, and extensive improvements are projected.

Plant No. 3. The equipment of this water-gas plant consists of three dry-seal, oblong, indoor boxes 16 feet by 12 feet horizontal section, and 12 feet deep. Each box contains two 5-foot layers of oxide. These boxes were originally designed for reversible flow. The superintendent conceived the idea that the capacity would be increased by making straight-flow boxes of them. The computed capacity was thereby reduced from 55,200 to 40,800 cubic feet per hour with gas containing 190 grains per 100 cubic feet. Whether decrease in efficiency has resulted from the change would be extremely difficult to determine, since recent improvements in the tar-extracting apparatus have probably increased efficiencies to a far greater degree than the change referred to decreased them. Since the purifiers are now overloaded nearly 100 per cent, a return to the former arrangement which would involve very little expense, is suggested.

Plant No. 4. This is an up-to-date small water-gas plant. The purifying equipment consists of two cylindrical reversible flow outdoor boxes 14 feet in diameter and 10 feet high, each containing two layers of oxide 4½ feet deep. The computed maximum hourly capacity is 25,000 cubic feet of gas, containing 175 grains H_2S per 100 cubic feet, and the reported maximum hourly make is 22,000. Since no air is admitted for revivification the reversibility of these boxes is a matter of less consequence than would otherwise be the case and the actual capacity is probably less than the computed. The plant is seldom operated more than 12 hours per day. In addition to these working boxes there are four square indoor water-seal, straight-flow boxes, 10 feet in diameter and 4 feet deep, designed to hold one 3-foot 6-inch layer of oxide each. These boxes are relics from a former coal-gas plant. They are connected by a center seal, so that only three of them can be in service at one time. The feasibility of putting these boxes into service so as to permit the use of generator fuel (bituminous) of higher sulphur content has been considered. Inasmuch as the coal suggested for use gives about 400 grains of H_2S in the gas, and the two boxes now in use would have a computed maximum hourly capacity of 22,600 cubic feet of gas of that sulphur content, it hardly seems that the slightly increased hourly capacity to be obtained from the small old-type boxes would warrant the expense of putting them into service and the inconveniences attending their use.

Plant No. 5. The purifying equipment of this plant was originally designed for coal gas. Extensive necessary repairs to the coal-gas equipment, difficulty of securing efficient retort-house labor, and the economies realized from making water gas from bituminous coal have resulted in at least temporary abandonment of the coal-gas equipment except in so far as it could be utilized in handling the water gas. The purifiers include two oblong dry-seal indoor boxes 15 by 10 by 8 feet deep, each containing two layers of oxide 3½ feet deep, and one square dry-seal box 20 by 20 by 5 feet deep, containing one layer of oxide 4½ feet deep. The boxes are all of the straight-flow type. The large shallow box can be used only as a catch box, being necessarily last in the series. The computed capacity of the purifiers is 32,700 cubic feet of gas per hour, and the overload during hour of maximum make is about 22 per cent. The present arrangement of the boxes fulfills present needs quite well. By arranging the two deep boxes for divided and reversible flow, the capacity could be increased to about 36,500 cubic feet per hour. The purifying costs reported are quite low.

Plant No. 6. The purifying equipment of this water-gas plant consists of two rectangular indoor boxes 16 by 12 by 11½ feet, each containing two 5-foot layers of oxide, in parallel with two boxes 20 by 20 by 5 feet containing one 4-foot layer of oxide each. The deeper boxes are arranged for reversible flow, but the shallow boxes have straight flow only. The computed capacity of the system as now arranged is about 60,000 cubic feet per hour. The overload at the time of maximum make is about 67 per cent. It is understood that a rearrangement of the boxes whereby all the boxes would be in series, has been considered. If such a change were practicable from other considerations, the capacity would be increased slightly but probably not sufficiently to pay. On the other hand, if plenty of overhead room is available, and it were practicable to double the depth of the two shallow boxes, making two layers in each box, and to arrange the whole system for reversible flow throughout, the capacity would be increased to over 100,000 per hour or to about the present maximum hourly production of the plant.

Plant No. 7. This large suburban water-gas plant is equipped with four rectangular water-sealed indoor boxes each containing two 5-foot layers of oxide. The gas flow in each box is reversible, gas entering at the middle and leaving at the top and the bottom of the box or vice versa. Rotation of the boxes can be accomplished in only one direction, as: 1 — 2 — 3 — 4, 2 — 3 — 4 —1, etc., but not 4 — 3 — 2— 1, etc. The computed hourly capacity of the system is about 206,000 cubic feet. It is about 40 per cent overloaded at time of maximum production. The purifying costs in this plant are the lowest reported by any plant inspected. The spent oxide from this plant showed a sulphur content rather above the average. The tar content was higher than the average found in all the plants and indicated that an excessive amount of tar had been allowed to enter the boxes at some time during the life of the oxide. At the time of inspection, the gas entering the boxes was reasonably clean. The indications are that purifying results could be improved somewhat if the load curve, shown in Figure 2, could be smoothed out, making the production through the boxes more uniform.

Plant No. 8. This suburban water-gas plant has two sets of purifying boxes in parallel. One set consists of four rectangular indoor boxes connected by a center seal which permits the use of only three boxes at a time. Each box is 24 by 24 by 7 feet deep and contains two layers of oxide 3 feet deep. The other set of boxes consists of four boxes, each 16 by 16 by 4½ feet deep. Each box contains a single layer of oxide 2½ feet deep. Three of the boxes are interchangeable, viz., any one of them can be made first box, but the position of one box fixes the order of the set. The fourth box of the set is a catch box and is always at the end of the series. All the boxes in both sets are arranged for straight upward flow. The computed maximum capacity of the two sets of boxes, as now arranged, is about 100,000 cubic feet of gas per hour. The capacities of the two sets are so different (about 4 to 1) that any rearrangement by placing in series would probably not be feasible. The set of larger boxes has a present capacity of about 80,000 cubic feet of gas per hour. If a new valving system could be installed, putting the fourth box into use and permitting reversal of flow, the capacity of the set would be approximately doubled, giving the entire system a total capacity of 180,000 cubic feet, more or less, per hour, which is about equal to the present maximum flow through the purifiers.

Plant No. 9. This plant produces about 60 per cent water-gas and 40 per cent coal-gas. Each kind of gas has an independent condensing system and the gases are mixed at the inlet of the purifiers. The purifying equipment consists of six boxes. Of these, four indoor boxes are arranged in two pairs, the members of each pair being connected in parallel and each pair acting as one divided-flow but non-reversible box. The paired boxes are 16 feet square in horizontal section and contain one layer of oxide each, three feet deep. The remaining boxes include an outdoor cylindrical steel box 25 feet in diameter and 10 feet high, containing two 4-foot layers of oxide, and an indoor catch box 16 by 16 by 4 feet deep, containing one 4-foot layer of oxide. The paired units and the cylindrical box can be arranged in various orders as 1 — 2 — 3, 3 — 1 — 2, and 2 — 3 — 1. The direction of flow except in the cylindrical box is non-reversible. The history of the development of this installation is not known. It seems likely that the original installation consisted of a four-box set arranged with a center seal as is common in old installations. In adding to the original equipment, an arrangement was made which is more flexible than is found in many plants. The computed hourly capacity is about 70,000 cubic feet per hour, which is ample for present needs.

Plant No. 10. This mixed-gas plant puts out about 90 per cent coal gas on the average. The peak load on the purifiers is rather sharp, the maximum hourly production being about 9.5 per cent of the maximum daily production. The purifiers include two cylindrical outdoor boxes 15 feet in diameter and 12 feet high arranged for reversible flow. Each box contains two 5-foot layers of oxide. The computed maximum capacity is about 30,000 cubic feet per hour and since the maximum hourly production through the boxes is said to be 75,000 cubic feet, there is a large load factor. The storage capacity in this plant is about 65 per cent of the maximum day. Water-gas and coal-gas are cleaned separately and mixed at the inlet of the boxes. The coal-gas production will probably average around 540,000 cubic feet per day, with an hourly production of about 20,000 cubic feet. The maximum daily gas output from the plant is reported to be about 800,000 cubic feet, which indicates that the maximum water-gas production may be about 32.5 per cent. The overload on the purifiers then is evidently due to the pumping of water-gas through the purifiers at an exceptionally high rate during peak load. It would seem, however, that if the maximum hourly output of the plant for a peak lasting say four hours at a time averaged no greater than the reported maximum make through the boxes, namely, 75,000 cubic feet per hour, and if the holders were full at the beginning of the peak, there would be no necessity of pumping gas through the purifiers so fast, even were it necessary to retain the city holder two-thirds full at all times. Even were the load curve smoothed out as much as possible, with the existing storage capacity it is likely that there would be a considerable overload during maximum hours. The logical extension of the purifying system would seem to be the installation of another box similar to those now in place. Another such box would bring the hourly capacity up to about 50,000 cubic feet per hour.

Plant No. 11. This small mixed-gas plant has an average output of about 200,000 cubic feet of gas per day, of which about one-fourth is water-gas. The maximum hourly purification is about 12,000 cubic feet. The purifying equipment consists of two cylindrical outdoor purifiers, 15 feet in diameter and 12 feet high, containing two 5-foot layers of oxide each. The flow is divided and reversible. The computed capacity of these purifiers is about 30,000 cubic feet per hour; therefore the system is much underloaded. It would be interesting to know the capital charges on an oversize system of this kind, but no figures are available. The size of the purifiers is ample to care for the growth in output for some years to come.

Plant No. 12. The purifying equipment of this plant which produces only 10 to 15 per cent water-gas, consists of four water-sealed indoor boxes 16 by 16 by 7.5 feet deep, each containing two layers of oxide 2.75 feet deep. Three of the boxes are arranged for rotation, the possible arrangements being 1 — 2 — 3, 2 — 3 — 1, 3 — 1 — 2, but not the reverse. The fourth box acts as a catch box and is always in last position. The computed capacity of this installation is about 44,800 cubic feet. If the boxes were valved for divided reversible flow, and 2 per cent of air used for revivification in place, the computed capacity would become about 61,000 cubic feet per hour. At present the installation is about 25 per cent overloaded at time of maximum hourly production, but since the load is being handled well and the cost of purification is low, there is little reason for making a change. The use of higher sulphur coals, if desirable or necessary for other reasons, might make the suggested change advisable.

Plant No. 13. The original purifying equipment of this plant, which makes about 40 per cent water-gas, consisted of two rectangular, water-sealed, indoor boxes, each 16 by 24 by 5 feet deep and containing one layer of oxide, 4 feet 4 inches thick. A cylindrical outdoor box, 15 feet in diameter and 12 feet high, containing two 5-foot layers of oxide was subsequently installed. The new box is of the divided-flow reversible type. On account of tar trouble, the first rectangular purifier was emptied and refilled with shavings to act as a shavings scrubber. The remaining rectangular box and the new outdoor box have a combined capacity of about 26,000 cubic feet of gas per hour. As is common in piece-meal installations of this kind, there is little opportunity for rotation of boxes; indeed in this plant there is only one arrangement possible. The rectangular box is always first in series, and the only change possible is reversal of flow in the second box. The overload during maximum hour is only about 15 per cent and there seems little reason for making a change on that account. Greater flexibility with respect to rotation of boxes would be desirable and would probably permit a more nearly complete fouling of the oxide and a reduction in purification labor. If a regular shavings scrubber were installed and the box now used for tar extraction were put into service again as a purifier, the capacity of the installation would be increased to about 35,000 cubic feet of gas per hour.

Plant No. 14. This plant makes about 95 per cent coal-gas and the purifying results obtained are considerably above the average. Seven boxes are in use, of which three boxes handle coal-gas exclusively, while the remaining four handle a smaller part of the coal-gas and all the water-gas. The purifiers are arranged in two parallel groups. One group consists of two 24 by 24 by 5 foot boxes, each box containing one layer of oxide 4 feet 6 inches in depth, and one 24 by 24 by 12 feet box containing two oxide layers, each 4 feet 6 inches in depth. These boxes are straight flow, but the sequence can be changed. The other group of boxes consists of four rectangular boxes, each 20 feet in diameter and containing one 2 foot 6 inch layer of oxide. These boxes are connected by a center seal and one box is always off. The computed hourly capacity of the first group is about 72,000 cubic feet of gas per hour, and that of the second group about 23,000 cubic feet per hour. Since the maximum hourly production is reported to be 70,000 cubic feet, the system is not overloaded, at least with gas of the present sulphur content. In case an increased capacity were necessary, it might be desirable to build up the two shallow 24-foot boxes to conform with the existing deep box of the same area. Such an enlargement with valves so arranged as to give complete reversibility would increase the hourly capacity of this group from 72,000 cubic feet to 157,000 cubic feet per hour, over 150 per cent of the present total capacity. Similarly, the four shallow boxes of the other group, if built up to double depth and arranged for complete reversibility, would have a capacity of about 100,000 cubic feet per hour.

Plant No. 15. This small mixed-gas plant produces about 40 per cent water-gas. The purifying equipment consists of four old-type, indoor, water-sealed boxes, connected by a center seal which permits the use of only three boxes at one time. The boxes are 10 by 8 by 4 feet and each contains one 3-foot 6-inch layer of oxide. The calculated capacity of the installation as now arranged is only about 6,000 cubic feet per hour, while the maximum load is reported to be 15,000 cubic feet, and the average load 7,000 cubic feet per hour. It is evident, therefore, that the installation is heavily overloaded. If the fourth box could be put into service except for the short interval required to change a box, the capacity would be increased to about 7,500 cubic feet per hour, which would still leave 100 per cent overload. A new purifying system, or the addition of one up-to-date box with proper valving, would perhaps be the best solution. The present single boxes, if built up to double height and arranged for complete reversibility of flow, would have a computed hourly capacity of about 22,600 cubic feet. Such conditions as head room available, strength of supports of the present system, condition of present boxes, and cost of the improvements would of course determine the best way to increase capacity. The fact that the purifying labor cost per 1,000 cubic feet in this plant is about double that of any other plant inspected (other small plants included) indicates that there is sufficient economy to be realized in labor charges to offset a considerable capital charge.

Plant No. 16. This plant makes about 93 per cent coal-gas. The purifying equipment is rather unique among the installations inspected. The system includes two outdoor concrete boxes, each 40 by 26 by 14 feet 4½ inches deep, each containing one 53-inch layer and one 62-inch layer, two indoor boxes each 30 by 20 by 5 feet deep, containing one 4½-foot layer, and two indoor boxes 20 by 20 by 4½ feet deep containing one 3-foot 9-inch layer each. The greater part of the purification is done in the two concrete boxes. These are placed first in the series and the order cannot be changed, nor is there any rotation of the two boxes though they are valved for divided reversible flow. Coal-gas only is purified in the concrete boxes. The old type indoor boxes follow the concrete boxes and the water-gas enters the inlet of the former. The old purifiers are all single-layer straight-flow boxes and are all arranged in series. The computed capacity of the whole system is about 190,000 cubic feet of gas per hour while the maximum hourly purification is reported to be only 40,000 cubic feet. It is evident, therefore, that the capacity is ample for some time to come. This plant was the only one inspected in which the oxide was revivified in the box by an air blast. Only the oxide in the large concrete boxes could be revivified in this manner. The way in which revivification is conducted in this plant will be discussed later.

SUMMARY OF CAPACITIES AND LOAD CONDITIONS

Tables 1 and 2 give the summarized data relative to load conditions, storage capacity, purifier capacity, etc., of the plants visited.

TABLE 1.—Purifier load conditions in medium-size water-gas plants of Illinois.

Plant.	Aver. daily output—M cu. ft.	Maximum daily output—M cu. ft.	Aver. hourly make thru purifiers—M cu. ft.	Max. hourly make thru purifiers—M cu. ft.	Holder capacity—M cu. ft.[1]	Holder capacity—per cent. max. day	H_2S in gas—grs. per 100 cu. ft.	Bushels oxide in actual use	Bushels oxide per million cu. ft., max. day	Calculated max. hourly capacity of purifiers—M cu. ft.	Max. hourly make—per cent of max. purifier capacity	Aver. hourly make—per cent of maximum purifier capacity
1	1650	1800	69	110	C – 1800 R – 60	103	180	18463	10250	241	45.6	28.6
2	1400	2000	58	110	C – 500 R – 112	30	100	4420	2210	40	277.0	145.5
3	617	712	26	80	C – 300 R – 75	53	190	4625	6500	41	196.0	63.7
4	170	227	7	22	C – 100 R – 50	66	175	2225	9810	25	88.0	28.0
5	360	430	15	40	C – 290 R – 30	72	130	3127	7280	34	119.2	44.8
6	1450	1600	60	100	C – 973 R – 80	66	125	6285	3920	54	186.0	111.6
7	3880	6000	161	280	C – 5000 R – 100	85	100	17125	2865	206	136.0	78.1
8	3200	4100	133	175	C – 500 R – 100	15	125	10900	2660	104	168.8	79.0
Averages.						61	141	....	5686	....	145.8	72.4

[1] In holder capacity column, the abbreviations "C" and "R" stand for City Holder and Relief Holder, respectively.

TABLE 2. Purifier load conditions in medium-size mixed-gas plants of Illinois.

Plant	Per cent water-gas	Aver. daily output—M cu. ft.	Max. daily output—M cu. ft.	Aver. hourly make thru purifiers—M cu. ft.	Max. hourly make thru purifiers—M cu. ft.	Holder capacity—M. cu. ft.[1]	Holder capacity—per cent of max. day	H_2S in gas—grs. per 100 cu. ft.	Bushels of oxide in actual use	Bushels of oxide per million cu. ft., max. day	Calculated max. hourly capacity of purifiers—M cu. ft.	Max. hourly make—per cent of purifying capacity	Aver. hourly make—per cent of purifying capacity
9	60	850	1200	35	60	C – 1280 R – 60	107	90	6450	5360	65	91.8	53.5
10	10	600	800	20	75	C – 300 R – 200	62	230	840	3560	30	45.0	65.8
11	25	200	230	8	12	C – 100 R – 50	65	340	2430	12300	29	39.4	28.4
12	12	550	780	23	50	C – 663 R – 112	99	220	3560	4690	45	111.5	51.1
13	40	440	500	18	30	C – 525 R – 21	109	150	2755	5500	26	114.5	69.8
14	5	1500	1800	63	70	C – 902 R – 70	54	165	10735	5960	96	73.0	65.5
15	40	170	200	7	15	C – 100 P – 75	85	350	675	3370	6	256.0	121.0
16	7	1400	1800	58	65	C – 1000 R – 390	77	470	22805	12700	191	34.0	32.9
Averages............................							82	252	......	6680	......	120.6	61.0

[1] In holder capacity column, the abbreviations C and R stand for City Holder and Relief Holder, respectively.

In studying Tables 1 and 2 several outstanding facts will be noted. Of the eight water-gas plants, six are loaded at maximum hour beyond the rated capacities of their purifiers, while on the other hand, only two of the eight are overloaded during hours of average production. It is evident then that the lack of uniformity of load is the chief cause of overload. It will be noted that the maximum hourly make is often more than double the average hourly make. (By "make" here, is meant flow through purifiers, *not machine make.*) By referring to the column marked "Calculated max. hrly. capacity of purifiers" and "Bushels of oxide per million cu. ft., max. day", we are able to form some opinion as to the reason for the overloaded or underloaded condition in each case. It is interesting to note that the average number of bushels of oxide per million cubic feet of gas purified on the maximum day, namely 5,686, agrees quite closely with the figure 5,365, which is the average of twenty-three water-gas plants whose results are reported by O. B. Evans in his paper, "Revivification in place", already mentioned. This indicates that Illinois plant conditions conform quite closely to conditions in plants all over the country, as is to be expected.

While, as shown in the tables, the holder capacity bears no direct relation to purifying capacity, it will be noted that in plants where the volume of oxide is small, large holder capacity assists in keeping down the overload. Plants 1 and 2 are interesting as the extreme examples of prevailing conditions. These plants have approximately the same output. Plant 1, however, has a holder capacity greater than its maximum day and an oxide capacity per million cubic feet of gas nearly twice the average. Plant 2, on the other hand, has a holder capacity only 30.6 per cent of its maximum day and an oxide capacity less than half the average. It is surprising to find that despite these great differences, the amount of sulphur absorbed per bushel by both of these oxides is almost the same with a very slight advantage in favor of Plant 1. The probable reasons for this similarity of results under such different conditions will be discussed later in connection with Table 3. Plant No. 8 (see Table 1) presents an apparently anomalous condition. Here the holder capacity is only 14.6 per cent of the maximum day and there is less than half the average amount of oxide per million cubic feet on maximum day found in all the plants, yet the overload is not nearly so great as in some other plants which are apparently more favored. The reason, however, seems to lie in the connection of this plant with a larger system whose holder capacity is to a certain extent available for use by this plant. In this case it is practically impossible to say just what average holder capacity is available for Plant No. 8, though its own individual holder capacity is as given. Probably at least four times the capacity stated is actually available when needed. Formerly many gas engineers considered that a well-designed plant should have a holder capacity at least equal to its maximum day, but the rapid growth of output in most of our plants has resulted in much smaller storage capacity ratios, as shown in Tables 1 and 2. When one considers that in spite of the smaller margin of safety which a small holder capacity gives, practically all of the larger plants operate year after year and give the public uninterrupted service, one is likely to conclude that there is no well-defined lower limit beyond which the gas operator dare not go. While this is true to a certain extent and distribution conditions are likely to be the determining factor in dictating an increase in storage capacity, it is evident that this condition is reflected back upon plant operation and affects purification, tar removal, and indeed any phase of the gas manufacturing process in which rate of gas flow is a factor.

In Table 2, the purifier load conditions in eight mixed-gas plants are presented. It is to be noted that the percentage of water-gas varies from 5 to 60 per cent of the total, averaging 25 per cent in all plants. It will be observed that the average holder capacity is larger in proportion to the maximum daily output than in the straight water-gas plants, as is also, in general, the volume of oxide per million cubic feet output on maximum day. Only one of the mixed-gas plants had an overload on its purifiers, during hours of average production. Since the coal-gas production in a mixed gas plant is usually fairly uniform in rate, the water-gas production taking the peak load, it is evident that in most cases where the purifiers are overloaded,the overload is caused by the production and purification of a large volume of water-gas in a short time. The purifiers are usually designed to handle the coal-gas production, but the water-gas production has often not been provided for. It will be noted that the hydrogen sulphide content of the gas, while about double that found in the eight water-gas plants, is considerably lower than in usual coal-gas practice, even with very low-sulphur coals. Had the sulphur content been higher, then the average purifying capacity would have shown an overload according to the relation shown in Figure 1.

EFFECT ON PURIFIER CAPACITIES OF THE USE OF ILLINOIS COAL

In connection with the influence of sulphur content of the gas on purifying capacity, it is interesting to note the effect of a change from the low-sulphur fuels used in a majority of the plants at the present time to fuels of higher sulphur content. The water-gas plants listed in Table 1, with the exception of Plants 2 and 8, were using Illinois or Indiana coals as generator fuel at the time of inspection. These two plants were using eastern cokes. The coals were in all cases selected low-sulphur coals. It will be noted that in some of the plants using coal, the H_2S content of the gas is no higher than in those using coke. In general, however, the increase in sulphur content with Illinois or Indiana low-sulphur coals as generator fuel would be from 50 to 100 per cent, viz., an H_2S content in the gas of 150 grains to 200 grains per 100 cubic feet might usually be expected. By reference to Figure 1 it will be noted that an increase of 50 to 100 per cent in the H_2S content of the gas does not have nearly the effect on the rated purifier capacity, when the H_2S content is small, that a similar percentage increase would have if the H_2S content were large. Hence a change from a low-sulphur eastern coke as water-gas generator fuel to a low-sulphur central district coal does not have as great an effect as the change from a low-sulphur eastern gas coal to a low-sulphur Illinois coal would have in coal-gas manufacture, it being assumed, as is usually the case, that the best eastern gas coals will average lower in sulphur content than the best Illinois coals. It is interesting to take numerical examples to study the effect of such changes.

Assume that an eastern coke as generator fuel gives gas containing 100 grains of H_2S per 100 cubic feet, and that a central district coal, using the same oil for enrichment gives gas containing 200 grains per 100 cubic feet. A plant which was designed to purify 100,000 cubic feet of gas of the lower sulphur content per hour would have its capacity reduced to 96,000 cubic feet—a decrease of only 4 per cent. On the other hand, if a low-sulphur eastern gas coal gave 300 grains of H_2S at the inlet to the purifier and an Illinois coal gave, as reported in some cases, 600 grains of H_2S, then a plant equipped to handle 100,000 cubic feet of the lower-sulphur gas per hour would have its capacity reduced by the change to about 83,000 cubic feet,—a decrease of about 17 per cent.

All the mixed-gas plants listed in Table 2 except Plants 13 and 15 were using low-sulphur eastern coals at time of inspection. In Plants 13 and 15, mixtures of 50 per cent eastern and 50 per cent Illinois coal were used. In neither of these plants was the sulphur content of the gas exceptionally high, but of course the 40 per cent water-gas made in both cases tended to reduce the sulphur in the mixed gas. It is evident that a decrease of 17 per cent or more in the purifying capacity of some of the mixed-gas plants given would be a serious matter. This difficulty might be met to a considerable extent by more attention to certain details of operation and selection of oxides, as has been previously discussed.

OBSERVED RELATION OF OXIDE VOLUME TO PURIFIER CAPACITY

In Tables 1 and 2 have been given the number of bushels of oxide in use in each plant per million cubic feet of gas output on maximum day. These figures have not been used in computing purifying capacities but are given partly because some engineers have been accustomed to rate purifiers in this manner, and partly to show the effect of oxide volume on purifying capacity in the various cases; especially in connection with storage capacity and load conditions. In Figure 3 is plotted the relation observed between oxide volume and maximum hourly purifying capacity in the various plants. The dotted line represents 1/10 bushel of oxide per cubic foot of gas purified during maximum hour, and is drawn in for convenience of comparison. The water-gas and mixed-gas plants are plotted separately. It is evident that the sulphur content of the gas determines, to a great extent, the position of the curves, and therefore any specification which calls for a certain number of bushels of oxide per 1,000 cubic feet of gas to be purified in a given time can at best be only incomplete. It is interesting to note that the curves for mixed-gas and water-gas plants, while quite close together for the smaller plants, appear to diverge after the 100,000 cubic feet per hour production is passed. Whether this would hold generally for the larger plants cannot be stated on account of insufficient data.

One rather remarkable thing is shown by Tables 1 and 2, namely, that purifiers may be worked far beyond their capacities and still do the work required of them. There does not seem to be any definite point, at least within the range observed, where the purifiers actually break down suddenly in their performance. It is conceivable that gas could be passed through a series of boxes containing new oxide at such a rate that hydrogen sulphide could be detected almost immediately at the outlet of the system. In testing oxides on a laboratory scale, this condition is found and is made use of to determine the relative rates of reaction of various oxides.

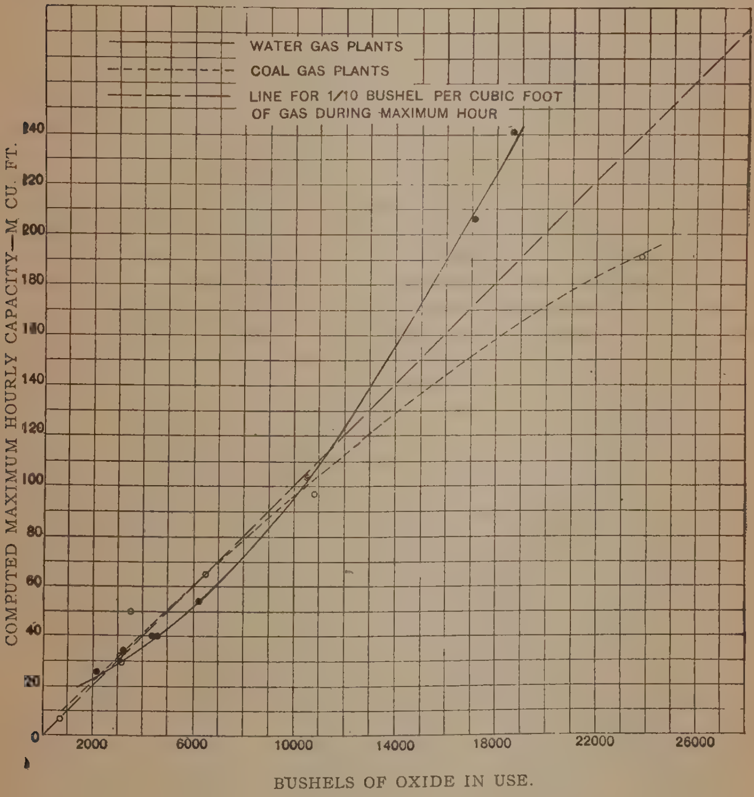

FIGURE 3—Observed relation of oxide volume to hourly purification capacity.

The time of contact called for by the Steere formula is approximately 6 minutes. Many comparatively slow oxides will not give a test for hydrogen sulphide immediately on a gas containing 100 grains per 100 cubic feet unless the time of contact is reduced to approximately 0.5 minutes. Other more rapid oxides will absorb all of the hydrogen sulphide from gas containing 100 grains of H_2S for several hours with this time of contact. As the oxide becomes fouler, however, the rate of absorption slows down and eventually some hydrogen sulphide will pass by the box. This will happen more quickly, other things being equal, in a purifying system that is overloaded. The result is that in an overloaded plant, other conditions being the same, more frequent changes will be necessary to keep the gas clean. When the frequency of changes becomes excessive the operator usually has one of the following choices; namely, to enlarge the purifying equipment, to rearrange existing equipment, to improve operation by increasing the absorption per bushel through more complete revivification in place, in some of the ways already discussed, or to find a more active oxide. Sometimes in the more extreme cases, only the first alternative will prove a feasible, permanent remedy.

REARRANGEMENT OF EQUIPMENT TO INCREASE CAPACITY

As just mentioned, the capacity of a purifying installation may sometimes be materially increased by minor changes whereby the existing equipment can be used in a more advantageous way, or the existing equipment may be enlarged, without changing its position or increasing the ground space occupied. Again, internal changes are possible whereby the purifiers may be made to accommodate a greater volume of oxide. Frequently, where the existing equipment is in good condition, such changes may be made at a fraction of the cost of an entirely new installation. Where additional capacity is needed it would often pay to consider (1) whether the best possible performance is being obtained from the present equipment, and (2) whether some minor changes would not secure sufficient additional capacity to defer the installation of new equipment to another time. Of course, in this as in any other construction, there is always some uncertainty as to the relative cost of installation now or a few years hence. Some of the rearrangements which may be made have been suggested in the detailed descriptions of the purifying installations inspected.

In the first place, it may be well to consider whether the amount of oxide is the maximum that the boxes will accommodate or whether the layers are of the greatest thickness permissible. In several instances it was found that the available space for oxide in the boxes, even allowing for the trays and a reasonable amount of free space, was considerably greater than would correspond to the number of bushels said to have been purchased for the boxes.

Again the amount of free space allowed may be excessive. In some cases the trays could be relocated without unduly diminishing the free space and with a distinct increase in capacity. Take, for example, a 4-box set of purifiers arranged for reversible flow, each box being 15 feet in diameter and 12 feet high, containing two layers of oxide each 4½ feet in depth. The hourly capacity, according to the Steere formula, would be 61,845 cubic feet, if the gas contained 200 grains of H_2S per 100 cubic feet. Now, assuming that the depth of each layer could be increased by 6 inches, the capacity would become 66,262, an increase of capacity of 14 per cent.

If the space available for oxide is being utilized to the fullest extent, then rearrangement may be in order. As has been suggested in several cases, reversible flow may help considerably. Let us assume an installation of three rectangular boxes, each 25 by 25 by 12 feet, each containing two 5-foot layers of oxide equipped for straight flow only, and with a given sequence as ABC, BCA, CAB. Such an installation purifying gas containing 200 grains of H_2S per 100 cubic feet would have a maximum hourly capacity, according to the Steere formula, of 133,000 cubic feet of gas.

Let us assume that this installation is overloaded and that it is desired to increase its capacity about 35 per cent. This increase may be accomplished in either of two ways, namely, by making the three existing purifiers perfectly flexible as to arrangement and reversibility or by installing a fourth box of the same size as the existing boxes, arranged for straight flow only. Leaving out of consideration for the present the difference in operating cost which would be in favor of the former arrangement, let us consider the probable relative costs of the two arrangements. At present prices, the cost of a new box of the size given, arranged for straight flow only, would probably be somewhere between $12,000 and $16,000. The installation of three 6-inch reversing valves, together with alteration of the manifold whereby the three existing boxes could be made entirely flexible as to arrangement and reversibility, would cost somewhere between $6,500 and $11,000, depending of course upon the amount of work and material that would be required and the amount of material from the old manifold that could be applied to the change. It is evident then that if the existing purifiers were in good condition and conveniently arranged for operation, rearrangement would be decidedly cheaper than the addition of another box of the same type. The economy of operation would also be distinctly in favor of rearrangement. A number of installations have been observed in which such a change with corresponding increase in capacity was apparently feasible.

In a few cases where old 4-box sets with center-seal connections are in use, a change in the connections whereby all the boxes could be used at one time would be advantageous.

A few cases have also been observed where a small increase in capacity could be realized by putting into series boxes now arranged in two parallel groups, but in most of the cases of this kind observed, such a change would hardly give enough increase in capacity to pay unless all the boxes were made reversible and arranged so as to be used in any desired sequence. In most cases where two parallel groups are in use, one of the groups consists of shallow single-layer boxes. Frequently these shallow boxes are of considerable cross-sectional area and where substantial foundations exist and plenty of head room is available, it might be feasible to build up the boxes to double height, installing an additional layer of oxide. Such a rebuilt group of boxes, if arranged for reversible flow and for rotation with the boxes of the deeper group, also equipped for reversible flow, would usually increase the capacity of the system very materially. For example, in Plant No. 6 already described, such a reconstruction, if feasible, would increase the capacity by about 66 per cent.

Of course, in making any alterations of the kinds described several things have to be considered. It would obviously be unwise to go to considerable expense to alter the connections of or reconstruct boxes which through long service had become unsound. And it might be unwise to prolong the use of boxes so arranged that the cost of operation was excessively high on account of inconvenient location or poor facilities for handling oxide. In any case it would be advisable to carefully compare the cost of rearrangement or reconstruction with the cost of new equipment necessary to give an increased capacity equivalent to that expected from the proposed change. The possibility that the space now occupied by purifiers especially when in substantial buildings, might be used to advantage eventually for some other purpose should also be considered. Since present practice is almost unanimously in favor of outdoor purifiers, it might be obviously unwise to perpetuate the use of valuable buildings for this purpose. The economic as well as the physical features of such a change need consideration. In all cases where possible changes have been suggested in this paper, it is to be understood that only the results to be expected from such changes have been considered. The considerations just named and physical conditions existing in the various plants might make the suggested alteration entirely impracticable. Each case would have to be considered carefully by itself.

RESULTS OBTAINED IN PLANTS INSPECTED

As will be seen clearly in Tables 3 and 4, purifier capacity alone will not necessarily insure good purifying results. Some of the best results found in Illinois plants at the present time are in overloaded plants.

A study of Tables 3 and 4 shows how difficult or impossible it is to harmonize the results actually obtained with the conditions under which they were obtained. In general, one cannot but be impressed by the difference between the results shown and those generally considered as typical of the best practice. Text books and treatises on gas manufacture usually state that spent oxide will contain from 50 to 60 per cent of sulphur, thereby implying that this degree of sulphiding is usually attained before the oxide is discarded. Yet the results shown in the tables indicate that in the average Illinois plant, at least, not nearly the usually accepted standard of performance is actually realized. In the water-gas plants, excluding Plant No. 5, which was a mixed-gas plant when the materal was fouled. the average percentage of sulphur in the spent oxide was only 21.7 per cent. In the mixed-gas plants, on the other hand, including Plant No. 5. the average was 37.4 per cent. These results are somewhat lower than those reported by Mr. Evans in the paper already referred to. The average absorption in the water-gas plants studied by him was 35 per cent sulphur and in the coal-gas plants 44 per cent. The latter figure is, we understand, for straight coal-gas, whereas the results reported by us in Table 4 are for mixed-gas plants. It is probable, too, that the plants whose results are reported by Mr. Evans are considerably larger in size than the plants in Illinois inspected by us, and therefore the conditions were probably more favorable for good results. Even so, it is apparent that the results generally obtained fall considerably below those considered as good standard practice.

In comparing Tables 3 and 4 one is impressed with the very considerable difference in sulphur absorption in the two gas-making processes. A number of reasons for the difference may be suggested. Coal-gas usually contains considerably more sulphur per unit volume than does water-gas, and according to the law of mass action, the greater concentration of the H_2S in coal-gas increases the rate of absorption. The coal-gas production is also more uniform and the peak loads on the purifiers usually represent a greater rate of water-gas purification rather than of coal-gas, so the average load conditions with coal-gas are more favorable. The ammonia in coal-gas, of which traces pass through the purifiers, may also assist materially in the purifying process by keeping the oxide alkaline. A section of the Purification Committee of the American Gas Association is now studying the effect of this factor.

TABLE 3.—*Purifying Results Obtained In Water-Gas Plants Inspected.*

Plant	Average daily production—M cu. ft.	Max. make hr.—per cent of max. purifier capacity	Bushels oxide per M cu. ft. max. hourly production	Kind of oxide in use	Weight spent oxide—lbs. per bushel	Sulphur in spent oxide—per cent dry basis	Tar in spent oxide—per cent dry basis	Sulphur—lbs. per bu. dry spent oxide	Tar—lbs. per bu. dry spent oxide	Grs. H_2S per 100 cu. ft. unpurified gas	Total gas purified per bu.—M cu. ft.[3]	Method of revivification	Purification labor costs—per M cu. ft.	Purification materials cost—per M cu. ft.	Total purification cost Pc. per M cu. ft.
1	1650	45.6	168	Rusted borings..	34.6	18.2	8.2	6.3	2.8	180	26.0	1% air in gas and outside of box.	...	...	....
2	1400	277.0	40	Rusted borings..	44.1	12.0	3.4	5.3	2.4	100	88.5	Outside box only	.50	.20	.70
3	617	196.0	58	Natural.......	26.9	26.7	19.0[1]	7.2	5.1	190	26.6	1½% air in gas and outside of box...	.77	.50	1.27
4	170	88.0	100	Rusted borings..	35.2	15.1	4.6	5.3	1.6	175	22.5	Outside of box only	.30	.80	1.10
5	360	119.2	78	Rusted borings..	65.3	40.1[2]	2.0	26.2	1.3	130	.	2% air in gas and outside of box. .	.10	.98	1.08
6	1450	186.0	63	Rusted borings..	33.3	33.0	1.8	11.0	0.6	125	65.5	1% air in gas and outside of box...	.20	.50	.70
7	3880	136.0	61	Natural	50.5	21.2	8.7	10.7	4.4	100	106.0	1% air in gas and outside of box...	.10	.40	.50
8	3200	168.8	62	Natural........	38.4	25.8	2.3	9.9	0.9	125	58.9	1½–2% air in gas and outside of box...........	.60	.50	1.10
Averages...	145.8	79	....	41.0	21.7	6.9	7.9	2.5	140	49.3	....	.37	.55	.92

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[1] Indications are that this oxide was tarred badly after it had absorbed most of its sulphur content.

[2] This plant was making straight water-gas when inspected but the spent oxide had been fouled chiefly by coal gas. Results averaged in Table 4.

[3] The figures in this column are based upon the assumption that the H_2S content averaged the same throughout the life of the oxide as at time of inspection.

TABLE 4.—*Purifying Results Obtained In Mixed-Gas Plants Inspected.*

Plant	Average daily production—M cu. ft.	Make max. hr., per cent of max. purifier capacity	Bushels oxide per M cu. ft. max. hourly production	Kind of oxide in use	Weight spent oxide—lbs. per bu.	Sulphur in spent oxide—per cent dry basis	Tar in spent oxide—per cent dry basis	Sulphur, lbs. per bu. dry spent oxide	Tar—lbs. per bu. dry spent oxide	Gr. H_2S per 100 cu. ft. unpurified gas	Total gas purified per bu., M. cu. ft.[1]	Method of revivification	Purification, labor cost, cents per M. cu. ft.	Purification material cost, cents per M. cu. ft.	Total purifying cost, cents per M. cu. ft.
5	360	119.2	78	Rusted borings..	65.3	40.1	2.0	26.2	1.3	130			.100	.980	1.080
9	850	91.8	107	"Home-made" rusted borings	62.8	44.1	5.3	27.7	3.3	90	228	Outside of box only	.608	.600	1.210
10	600	245.0	38	Rusted borings..	65.4	37.2	2.1	24.3	1.4	230	78	Outside of box only	.357	.396	.750
11	200	30.4	240	Rusted borings..	70.3	40.7	3.2	28.7	2.2	340	63	Outside of box only	.386	1.255	1.640
12	550	111.5	71	"Home-made" rusted borings	71.0	32.5	6.0	23.1	4.3	220	78	Outside of box only	.540		.540
13	440	114.5	92	Rusted borings..	58.9	30.2	1.7	17.8	1.0	150	88	Outside of box only			
14	1500	73.0	153	"Home-made" rusted borings	67.2	44.4	4.8	29.8	3.2	165	131	Outside of box only	.840	.200	1.040
15	170	250.0	45	Rusted borings	50.0	21.4	4.4	10.7	2.2	350	23	Outside of box only	1.407	.840	2.250
16	1400	34.0	351	"Home-made" rusted borings	75.0	30.4	2.6	27.3	2.0	480	12	In oil box with air	.344	.576	.920
Averages		120.6	138		65.1	37.4	3.6	24.0	2.3	239	91		.572	.692	1.180

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[1] The figures in this column are based upon the assumption that the H_2S content of the unpurified gas throughout the life of the oxide was same as at time of inspection.

In the columns of Tables 3 and 4 marked "Total gas purified per bushel—M cu. ft.", the assumption has been made that the H_2S content of the gas was constant and the same as at the time of inspection. The figures reported are probably quite as accurate as the results reported in the purification records of most plants, but owing to the uncertainty of the assumption on which they are based, no claims to great accuracy are made for them.

CAUSES OF LOW EFFICIENCIES

OVERLOAD

The cause of the discrepancy between standard purification practice and the actual results observed in Illinois plants is a complex one. It is probably due to some extent to overload. That an overloaded condition of the purifying equipment can result in low-sulphur absorption is evident from a consideration of the effect of overload on operation. Where the gas has to be passed through the boxes at an excessive rate, although the oxide may at first completely purify it, the condition where it cannot completely remove the sulphur is reached sooner than would be the case if the rate of gas flow were slower. The time between box changes will therefore be shorter with the faster rates.

The complete absorption of hydrogen sulphide requires a measurable time of contact between gas and oxide. When the material is fresh a shorter time of contact seems adequate, but as the surface of the oxide becomes sulphided, a longer time of contact seems to be necessary for complete absorption of hydrogen sulphide by the inner particles of oxide. With very rapid rates of gas flow, the absorption seems to be at first largely superficial, and after the superficial capacity of the material has been utilized, longer contact seems necessary for complete absorption of H_2S.

The absorption of sulphur per change will therefore be less with an overloaded purifying system, and to get the same absorption an oxide will have to be handled more times than would be necessary were the flow slower. Each time an oxide is handled it becomes finer from breakage, and with frequent handling the oxide soon becomes so fine as to favor packing and back pressure. Conditions which lead to overload of the purifiers also usually favor overload of the other gas-cleaning equipment, so that more tar is likely to be carried into the boxes, other conditions being the same, when the purifiers are worked beyond their capacities. Therefore, more rapid tarring and excessive breakage of oxide in an overloaded plant are likely to result in depreciation and discard of the purifying material sooner than in a plant operated at normal capacity.

We note, however, that some of the overloaded plants excel other similar underloaded plants in absorption realized, so this does not appear to be the only or perhaps the most serious cause.

TAR IN THE GAS

Tar in the gas is also a contributory cause, but it is difficult to say in a particular case to just what extent efficiency was reduced by it, for some of the spent oxides collected that are high in tar are also high in sulphur. This would lead one to think offhand either that tar has little effect on sulphur absorption or that most of the sulphur absorption had taken place before the oxide was tarred. In order to determine roughly the effect of tar in the oxide upon efficiency of its absorption of hydrogen sulphide, an experiment was carried out, the results of which are shown in Figure 4.

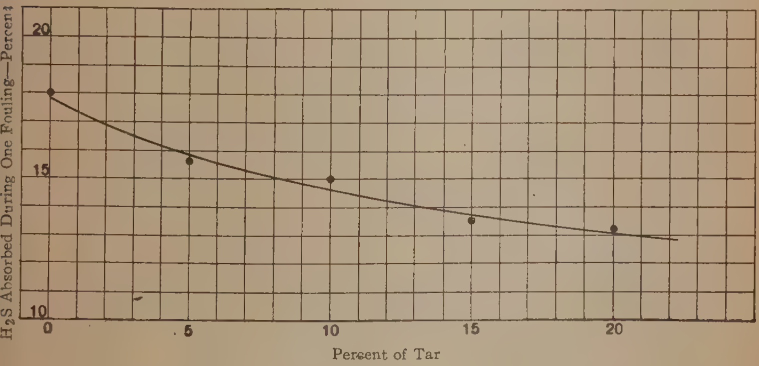

FIGURE 4. Effect of tar on the absorption capacity of an oxide for hydrogen sulphide, first fouling.

The absorption capacity of a particular oxide for pure hydrogen sulphide was determined by the Kunberger method. Portions of the same oxide were then treated with various percentages of tar, and their absorption capacities after treatment were similarly determined. The tar was applied by making up a solution of water-gas tar in pure carbon bisulphide. Each sample of oxide was treated with an amount of this tar solution corresponding to the required percentage of tar. The tar solution and oxide were thoroughly mixed; then the carbon bisulphide was removed by evaporation in the air. The tar was left deposited on the oxide, which was then subjected to the fouling test.

While the conditions of the test and the results obtained are not strictly comparable with practical conditions, they indicate something con-

TABLE 5.—Distribution of tar through beds of oxide in two plants.

PLANT A—WATER-GAS[1].				PLANT B—COAL-GAS[2].			
Level where sampled	Per cent moisture and light oil	Per cent sulphur—dry basis	Per cent tar—dry basis	Level where sampled	Per cent moisture and oils	Per cent sulphur—dry basis	Per cent tar—dry basis
Top of upper layer	39.8	16.86	3.28	Surface of layer	16.2	23.86	2.20
Bottom of upper layer	28.0	23.28	3.46	1 foot below surface	25.3	28.21	.96
Top of lower layer	32.8	24.01	1.60	2 feet below surface	22.4	29.78	1.50
Bottom of lower layer	38.6	17.69	1.59	Bottom of layer	28.6	28.77	1.70

[1] Load on purifiers 169% of rated capacity at time of maximum make. Box contained 2 layers of oxide, each 3 ft. deep.

[2] Load on purifiers 73% of rated capacity at time of maximum make. Box contained only 1 layer of oxide, 2 ft. 6 in. deep.

cerning the effect of tar in coating oxide and decreasing its absorption capacity. Of course, the ability of the material to revivify is also affected, so that tar is a disadvantageous thing to have present at any and all times.

It was thought at first that the reason for the comparatively high sulphur percentages in some rather tarry oxides might be due to the tar-extracting action of a portion of the oxide batch, permitting the remainder of the batch to foul more completely on tar-free gas. It was expected that analyses of oxide from different levels in an upward-flow box would show a concentration of tar in the lower part of the box. Samples of oxide were therefore taken in two plants, one water-gas and the other coal-gas, at various levels. Each sample was collected from several points at the same level, to insure a representative sampling. Analyses of the samples and the levels where taken are shown in Table 5. It is surprising to note that the tar is not concentrated at the bottom. In the water-gas plant the greatest percentage of tar was found in the bottom of the upper layers, while in the coal-gas box, the top of the batch contained the most tar. Likewise, there is no apparent relation between the percentages of tar and sulphur in these batches. The highest percentage of sulphur in each case is coincident neither with the lowest, nor with the highest percentage of tar. One naturally concludes that each batch must have absorbed the larger part of its sulphur in each case before the tar was present to any great extent. The concentration of tar in the upper part of the batch may be caused by tar condensing out of the gas, due to the cooling action of the purifier box cover, and dropping down into the oxide. Of course, in practice the accumulation of tar is relatively slow, and since the rate of sulphur absorption in a given part of an oxide batch is slowing down as the concentration of iron sulphide increases, it is difficult to determine in a particular case to just what extent the accumulation of tar is affecting the performance.

The means of removing tar differs considerably in different plants. Table 6 shows the gas-condensing and scrubbing equipment in use in the different plants. For convenience, the final tar-extracting apparatus in each case is printed in italics. It will be noted that the shavings scrubber appears to be the favorite tar-extracting equipment in water-gas plants, though the P. & A. tar extractor and the bubble washer are preferred in a few plants. The writers of this bulletin have had no opportunity to study the relative merits of these various types of apparatus under conditions which were comparable. As will be noted in the table, the amount of tar in the gas at the inlet of the purifiers varies considerably even with the same type of tar extractor, and it seems to be possible, under favorable conditions, to obtain practically complete extraction with any one of these

TABLE 4.—*Average analytical and heat values for No. 1, No. 2, No. 5, No. 6 and No. 7 coals by counties and for the district*

No. of analyses	No. of mines	County	Coal bed	Proximate analysis of coal 1st: "As recd," with total moisture. 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
				Moisture	Volatile matter	Fixed carbon	Ash				
NO. 1 COAL											
3	1	Christian	1	11.31	38.89	40.94	8.86	2.35	.64	11603	....
				Dry	43.85	46.16	9.99	2.65	.72	13081	14717
4	1	Fulton	1	12.71	38.19	39.79	9.31	4.70	.62	11387	....
				Dry	43.77	45.61	10.62	5.37	.70	13052	14939
7	2	Average	1	12.11	38.49	40.29	9.12	3.69	.63	11479	....
				Dry	43.80	45.84	10.35	4.20	.71	13065	14844
NO. 2 COAL											
4	1	Christian	2	12.61	38.39	41.43	7.42	3.32	.21	11601	....
				Dry	44.11	47.41	8.48	3.80	.24	14276	14746
1	1	Fulton	2	14.87	35.80	43.88	5.45	....	....	11641	....
				Dry	42.06	51.54	6.40	3.69	....	13674	14083
8	1	McLean	2	11.53	41.45	37.53	9.25	3.17	.98	11445	....
				Dry	47.12	42.43	10.45	3.57	1.10	12936	14686
1	1	Peoria	2	12.05	40.49	37.88	9.58	3.94	....	11316	....
				Dry	46.03	43.07	10.90	4.48	....	12866	14698
2	1	Schuyler	2	12.54	37.81	42.09	7.55	4.55	....	11731	....
				Dry	43.26	48.12	8.63	5.19	....	13412	14968
16	5	Average	2	12.16	39.92	39.49	8.36	3.44	.72	11524	....
				Dry	45.50	44.99	9.50	3.89	.81	13122	14701
NO. 5 COAL											
48	14	Fulton	5	15.36	35.04	38.00	10.90	3.13	1.48	10421	....
				Dry	41.95	44.90	13.14	3.68	1.70	12295	14465
8	2	Logan	5	14.40	35.09	38.87	11.71	3.39	1.28	10512	....
				Dry	42.85	44.15	13.16	3.72	1.49	12296	14418
5	2	McLean	5	12.02	37.18	37.40	13.41	3.43	1.22	10723	....
				Dry	43.84	41.78	14.38	4.30	1.39	12206	14572
8	2	Macon	5	14.14	36.83	38.69	10.26	3.55	.50	10698	....
				Dry	42.56	45.14	11.93	4.14	.58	12451	14427
18	6	Peoria	5	15.09	35.39	38.17	11.34	3.04	1.51	10536	....
				Dry	42.33	43.98	13.69	3.71	1.77	12372	14616
15	5	Sangamon	5	14.35	37.30	37.57	10.78	4.16	.59	10555	....
				Dry	43.55	43.86	12.59	4.86	.69	12323	14415
3	1	Tazewell	5	14.72	37.55	38.43	9.64	3.09	1.20	10810	....
				Dry	42.74	44.65	11.28	3.62	1.40	12624	14496
105	37	Average	5	14.83	35.73	38.05	11.07	3.33	1.24	10497	....
				Dry	42.43	44.49	13.01	3.95	1.43	12326	14474

TABLE 4—Concluded

No. of analyses	No. of mines	County	Coal bed	Proximate analysis of coal 1st: "As recd," with total moisture. 2nd: "Dry" or moisture free.				Sulphur	CO₂	B. t. u.	Unit coal
				Moisture	Volatile matter	Fixed carbon	Ash				
NO. 6 COAL											
1	1	Macon	6	15.42	39.68	44.05	10.85	4.25	....	11814	....
				Dry	41.96	46.57	11.47	4.50	....	12492	14396
1	1	Peoria	6	17.16	35.66	38.11	9.07	2.78	....	10465	....
				Dry	43.05	46.00	10.95	3.36	....	12633	14371
6	2	Sangamon	6	14.20	37.99	38.11	9.70	4.26	.42	10671	....
				Dry	44.28	44.42	11.30	4.96	.49	12437	14329
1	1	Schuyler	6	12.99	37.28	38.62	11.11	3.75	....	11057	....
				Dry	42.84	44.40	12.76	4.31	....	12709	14827
2	2	Tazewell	6	14.33	36.85	38.58	10.26	3.18	....	10297	....
				Dry	43.01	45.03	11.97	3.72	....	12597	14522
11	7	Average	6	14.49	37.66	38.78	9.97	3.88	.42	10813	....
				Dry	43.60	44.87	11.54	4.49	.49	12514	14418
NO. 7 COAL											
1	1	Peoria	7	14.54	34.01	37.07	14.38	3.05	....	10155	....
				Dry	39.79	43.38	16.83	3.57	....	11881	14493

Table 5.—*Average analyses of Illinois coals by districts*

(Figures are for coal as received)

Analyses by J. M. Lindgren under general supervision by Prof. S. W. Parr

District	Coal bed	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B. t. u.	Number of samples averaged
LaSalle	2	16.18	38.83	37.89	7.08	2.89	10981	33 from 11 mines
Murphysboro	2	9.28	33.98	51.02	5.72	1.29	12488	15 from 5 mines
Rock Island and Mercer counties	1	13.46	38.16	39.75	8.63	3.59	11036	14 from 4 mines
Springfield-Peoria ([a])	5	15.10	36.79	37.59	10.53	3.52	10514	51 from 17 mines
Saline County	5	6.75	35.19	48.72	9.04	2.92	12276	27 from 7 mines
Franklin and Williamson counties	6	9.21	34.00	48.08	8.71	1.53	11825	58 from 16 mines
S. W. Illinois west of Duquoin anticline	6	12.56	38.05	39.06	10.33	4.01	10847	76 from 25 mines
Danville: Grape Creek coal	6	14.45	38.29	38.75	9.98	2.93	11113	18 from 2 mines
Danville: Danville coal	7	12.99	38.29	38.75	9.98	2.93	11143	18 from 2 mines

[a] The difference in the average analysis here given from that given in Table 4 is explained by the fact that (1) a somewhat larger area is covered by Table 4, and (2) more analyses have been used in arriving at the Table 4 average, some of them from the United States laboratories, and others made very recently.

STRUCTURE

The structure of the several counties covered by this report is discussed in some detail by county units in Part II. For the convenience of those interested in the structure of District IV as a whole, Plates I and III have been prepared.

On the map, Plate I, structure contours on the top of No. 5 coal show the lay of the rock in the area as closely as it can be determined from a study of outcrops and available drill and shaft records. The locations of all the active shipping mines in the district and of such other mines and borings as gave information useful in the preparation of the map, are also shown, as well as the position of the outcrop of No. 5 coal.

Plate III consists of three structure sections, two approximately east and west and one north and south across the district.

The numbered red lines on the map, Plate I, are structure contours on No. 5 coal. Any given contour connects all known points where the elevation of No. 5 coal is the same and the numbers on the lines state that elevation. In Plate I, the contour interval used west of Illinois River is 25 feet, which means that between any two adjacent contours the coal bed dips more or less uniformly from the higher elevation to the lower. East of the Illinois the interval is 50 feet, and a fifty-foot change in elevation from one contour to the next is implied.

Study of the structure shown on the map shows that the general regional dip is to the southeast, from 650 feet above sea level in south-central Knox County to only 50 feet above sea level in southeastern Mason County.

This regional dip in the direction of the major synclinal basin that roughly parallels the La Salle anticline. In Eastern McLean County is found the only exception to the general regional dip –there the strata are beginning to rise, as shown by the No. 5 coal contours, to form the west flank of the La Salle anticline.

It will be noticed that the contours are more irregular in Peoria, Fulton, and Sangamon counties than in the remainder of the area. This difference does not mean that in those counties dips are more variable than they are elsewhere; in all probability irrgularities of the same sort characterize the whole district, but outside the counties mentioned, well logs and outcrops are so few and scattered that it was not possible to work out details of structure.

PART II.—COUNTY REPORTS

INTRODUCTION

The detailed description of the geological conditions in the district as affecting mining is thought to be most conveniently presented by the county unit. County reports are therefore presented in alphabetical order in the following pages.

A complete list of shipping mines in District IV for the year 1920 is given herewith as table 6.

TABLE 6.—*List of shipping mines in District IV, 1920*

Map No.	Name of company	No. or name of mine	Location					Surf. elev.	Depth to No. 5 coal(a)	Alt. of top of coal	No. of coal	Thickness		Production 1917 (b)	Production 1920 (b)
			¼	¼	Sec.	T. N.	R.								
	Fulton County								*Feet*			*Ft.*	*in.*		
1	Alden Coal Co.	No. 5	Cent.	N½	2	8	4 E.	745	185	560	5	4	4	120.020	4.826
2	Alden Coal Co.	No. 6	NW	SW	27	8	4 E.	762	190	572	5	4	3	127.839	115.105
3	Alden Coal Co.	No. 8	Cen.	SE	3	8	4 E.	680 =	70	610	5	4	0	163.876	143.979
4	Big Creek Coals, Inc.	No. 2	SE	SW	16	6	4 E.	578	.....	578	5	5	0	300.127	238.400
5	E. G. Bader	Eclipse	NW	SE	14	3	1 E.								21,259
6	Big Creek Coal Co. (abandoned)	No. 3	SE	NE	20	6	3 E.	683	55	628	5	5	2	113.717	.....
7	Big Creek Coals, Inc.	No. 4	NE	SE	22	6	4 E.	637?	82	555?	5	5	6	207,007	158.390
8	Big Six Coal Co.	Big Six	NE	NW	31	8	3 E.	.....	drift	635 =	5	4	0	.....	.....
9	Binzel Coal Co.	No. 1 (Binzel)	NW	SE	4	8	4 E.	660 ±	41	620	5	4	8	.....	36.953
10	Canton Coal Co.	No. 1	NW	SW	34	8	4 E.	740	180	560	5	4	1	.....	154.973
11	Coal Creek Mining Co.	Parrville	NW	SW	30	8	3 E.	.....	drift	638	5	4	0	41.930	24.035
12	Cripple Creek Coal Co.	No. 1	SW	SW	24	6	3 E.	.....	drift	.....	5	4	8	.....	200.338
13	Cripple Creek Coal Co.	No. 2	SW	SW	24	6	3 E.	.....	drift	.....	5	.....		.....	
14	Eagle Mining Co.	Eagle	SE	SE	32	7	4 E.	683	103	580	5	4	10	128.085	91,021
15	Genuine Norris Coal Mining Co.	Genuine Norris	SE	SE	34	8	4 E.	735	180	555	5	4	1	66.129	.....
16	Maplewood Coal Co.	No. 1	SE	NW	11	8	4 E.	720	122	598	5	4	2	78.441	77.503
17	Maplewood Colliery Co.	No. 2	NW	SE	15	8	4 E.	760	146	614	5	4	2	132.053	60.250
18	Middleton Coal Co.	Middleton	NE	SW	33	7	4 E.	660	60	600	5	4	8	.....	35.957
19	Monmouth Coal Co.	No. 1	NW	NW	11	7	4 E.	705 =	142	563 ±	5	4	6	172.413	136.304
20	National Coal Mining Co.	National	SE	SW	5	8	4 E.	710	105	605	5	4	0	150.074	155.551
21	Rawalt Coal Co.	Rawalt	NE	NE	36	7	4 E.	655	76	579	5	4	8		20,667
22	Shuler and Long	Parrville	NW	NW	31	8	3 E.								7,021
23	Silver Creek Colliery Co.	No. 1	SW	SE	4	8	4 E.	675	41	634	5	4	0	279.708	186.798
24	Simmons Coal Co.	Simmons	SW	SW	14	7	4 E.	682	121	561	5	4	6	137.674	88.216
25	Spoon River Colliery Co.	Ellisville: No. 1	NE	SW	28	8	2 E.	.....	36[c]	.....	1	4	6	102.239	78.405
26	Star Coal Co.	Fiatt: No. 1	NW	SW	28	7	3 E.	687	56	631	5	4	10	37.000	41.721
27	Star Coal Co.	No. 3	NW	SE	20	6	3 E.	659	26	633	5	4	11	147.278	64.449
	Logan County														
1	Citizens Coal Mining Co.	Citizens	SW	NW	32	20	2 W.	590	266	324	5	5	0	177.849	155.223
2	Latham-Lincoln Mining Co.	Latham	SE	NE	30	20	2 W.	600 ±	280	320 =	5	.....		256.642	239.877
3	Lincoln Mining Co. (abandoned)	No. 1	SE	NE	36	20	3 W.	587	280	307	5	5	0	162.020	.....

(a) Unless otherwise specified.

(b) For the fiscal year: as reported to the Department of Mines and Minerals and published in the annual coal reports.

(c) No. 1 coal

TABLE 6.—*List of shipping mines in District IV, 1920*—Continued

Map No.	Name of company	No. or name of mine	Location					Surf. elev.	Depth to No. 5 coal(a)	Alt. of top of coal	No. of coal	Thickness		Production 1917(b)	Production 1920(b)
			¼	¼	Sec.	T. N.	R.								
	Macon County								*Feet*			*Ft.*	*in.*		
1	Decatur Coal Co.	No. 2	NE	NW	14	16	2 E.	......	610	......	......	4	0	73,937	90,504
2	Macon County Coal Co.	No. 1	W½	SW	14	16	2 E.	685 ±	555	130	5	4	3	180,105	121,904
3	Niantic Carbon Coal Co.	Niantic	SW	NW	12	16	1 W.	603 ±	360	243	5	5	6	4,962	6,412
	McLean County														
1	McLean County Coal Co.	McLean Co.	NW	SE	5	23	2 E.	785	375	410	5	4	6		
2	C. H. H. Fisher, Receiver	Colfax: No. 1	SE	SE	3	24	5 E.	750	513(d	272	2	3	6	77,083	43,357
									406(e	344	6?	5	5	12,329	......
	Menard County														
1	Union Fuel Co.	No. 4: Athens	SW	NW	36	18	6 W.	605	203	402	5	5	8	155,878	99,114
	Peoria County														
1	Clark Coal and Coke Co.	Empire: No. 2	SW	SE	10	8	7 E.	650 ±	181	469	5	4	0	232,594	243,559
2	Collier Cooperative Coal Co.	No. 1	SE	NE	26	8	7 E.	635 ±	106	529	5	4	3	61,314	41,360
3	Crescent Coal Co.	No. 1	SE	NW	12	8	7 E.	470	196	274	5	4	6	158,340	138,575
4	East Mapleton Coal Co.	No. 1	SW	SE	19	7	7 E.	472	22¼ (drift)	450 ±	5	4	6	28,454	......
5	East Mapleton Coal Co.	East	NE	SE	20	7	7 E.	450 ±	drift	450 ±	5	5	0	......	......
6	John A. Hoffman	Blue Fly	NW	SW	36	9	7 E.	465	106(d)	359	2	2	6	......	......
7	Lancaster Coal Co.	No. 1: Kingston	SW	NE	27	7	6 E.	......	drift	......	5	4	5	26,122	23,209
8	Leitner Coal Co.	Leitner	NW	NW	12	7	7 E.	460?	17 (drift)	443	5	4	8	27,619	27,597
9	Logan Coal Co.	No. 1	NE	SE	10	8	6 E.	735?	236?	499?	5	...	...	118,466	101,708
10	M. E. Case Coal Co.	Walben: No. 1	SE	NW	1	7	7 E.	487	16 (drift)	471	5	4	2	221,254	105,505
11	Newsam Bros.	Glasford: No. 4	NE	NE	28	7	6 E.	615?	148?	467?	5	4	6	110,587	112,311
12	Newsam Bros.	LaMarsh: No. 5	NE	NE	8	7	7 E.	......	......	......	5	4	6	......	55,262
13	Warsaw Coal Co.(f)	Warsaw	NE	NW	24	9	6 E.	625	......	......	5	4	4	94,256	70,488
14	Wolschlag Cooperative Coal Co.	Wolschlag	NE	SW	36	8	7 E.	......	......	......	5	..	...	273,315	131,661
	Sangamon County														
1	Bissell Coal Co.	Bissell	NW	SW	8	16	4 W.	568	235	334	5	5	6	20,657	153,934
2	Chicago-Springfield Coal Co.	C-S	SW	NW	12	16	5 W.	565	230	335	5	6	2	347,523	182,082
3	Chicago, Wilmington & Franklin Coal Co.	Thayer	SW	SW	34	13	6 W.	648	300	348	6	7	0	......	568,001

(d) No. 2 coal.

(e) Identification of coal uncertain; possibly No. 6.

(f) In the SW. ¼ of this section, the Warsaw Coal Company has two drift mines, No. 3 and No. 4, which are run as one mine, the tipple being in the NW. ¼.

TABLE 6.—*List of shipping mines in District IV, 1920*—Concluded

Map No.	Name of company	No. or name of mine	Location ¼	Location ¼	Location Sec.	Location T. N.	Location R.	Surf. elev.	Depth to No. 5 coal (a)	Alt. of top of coal	No. of coal	Thickness		Production 1917 (b)	Production 1920 (b)
									Feet			*Ft.*	*in.*		
4	Citizens Coal Mining Co.	"A"	NW	NW	32	16	5 W.	590 ±	207	383 ±	5	5	4	60,458	171,331
5	Citizens Coal Mining Co.	"B"	SW	SE	31	16	5 W.	605 ±	204	401 ±	5	5	9	235,947	193,020
6	Dawson Coal Mining Co.	Dawson	NW	NW	8	16	3 W.	597	250	347	5	5	2	58,507	106,941
7	Illinois Coal & Coke Corporation	No. 400	SW	SW	14	16	5 W.	582	244	338	5	5	9	219,513	199,527
8	Lincoln Park Coal & Brick Co	Lincoln Park	SE	SW	21	16	5 W.	569	204	365	5	5	9	98,846	101,331
9	Madison Coal Corporation	No. 6	NE	SW	21	13	5 W.	610 ±	330	280	6	....	....	....	777,561
10	Panther Creek Mines, Inc.	Panther Creek	NE	NE	35	14	6 W.	....	....	....	6	....	....	....	318,752
11	Peabody Coal Co.	No. 5	SW	NE	12	13	5 W.	628	322	306	6	6	0	....	183,238
12	Peabody Coal Co.	No. 6	SE	SE	36	17	5 W.	550	198	352	5	6	0	429,721	379,052
13	Peerless Coal Co.	Peerless	NW	SW	13	16	5 W.	580	223	357	5	5	10	450,455	420,061
14	Sangamon Coal Co	Sangamon: No. 2	NE	NE	26	16	5 W.	592?	250?	342?	5	5	10	330,339	348,602
15	Sangamon Coal Co.	No. 3	SE	NW	8	17	5 W.	602	206	396	5	6	1	25,082	36,803
16	Sangamon County Mining Co.	Jefferson	NW	SW	1	15	5 W.	582	240	342	5	5	9	84,313	224,422
17	Spring Creek Coal Co.	Spring Creek	NW	SE	19	16	5 W.	....	....	....	5	....	....	143,463	196,496
18	Springfield Cooperative Coal Co.	Cooperative	NW	NW	23	16	5 W.	585	245	340	5	....	....	191,800	164,730
19	Springfield District Coal Mining Co.	Cora: No. 51	SW	SE	27	17	5 W.	530	145	385	5	....	....	197,698	145,104
20	Springfield District Coal Mining Co.	No. 52	NW	SE	10	16	4 W.	550	232	318	5	5	11	500,517	323,621
21	Springfield District Coal Mining Co.	Woodside: No. 53	NW	SW	3	15	5 W.	600	245	355	5	6	6	296,983	278,081
22	Springfield District Coal Mining Co.	No. 54 (Black Diamond)	SW	SE	15	13	6 W.	603	244	359	6	....	....	....	350,190
23	Springfield District Coal Mining Co.	No. 55	SW	NW	9	15	5 W.	607	250	357	5	5	11	320,295	276,768
24	Springfield District Coal Mining Co.	Capital: No. 57	NE	NW	35	16	5 W.	598	220	378	5	6	0	213,201	161,760
25	Union Fuel Co.	No. 2	SE	NE	6	15	4 W.	575 ±	220	350	5	5	8	180,711	141,065
26	Union Fuel Co.	No. 3	NE	NE	10	13	6 W.	628	264	364	6	6	8	....	168,873
27	Union Fuel Co.	No. 5	SE	NW	17	17	4 W.	590	267	323	5	5	8	....	14,193
28	West End Coal Co.	West Shaft	SE	NE	29	16	5 W.	530	145	385	5	5	10	283,673	231,060
	Tazewell County														
1	Groveland Coal Mining Co.	No. 1	SW	NW	7	25	4	535?	85	450?	5	4	4	217,491	201,370
2	Groveland Coal Mining Co.	No. 2	NE	NE	18	25	4	614	165	449	5	4	4	....	568,001
3	Johnston City Big Muddy Coal and Mining Co.	No. 3	NW	NW	6	24	4	600	205	395	5	4	8	....	21,007
4	Lake Erie Mining Co.	Lake Erie	NW	NE	6	25	4	....	....	....	5	4	4	27,883	88,007
5	Tazewell Coal Co.	Tazewell	SW	NW	6	24	4	580	162	418	5	4	8	146,627	112,540
6	Ubben Coal Co.	Ubben	SE	SW	1	24	5	540	100	440	5	4	10	29,000	36,696

CASS COUNTY

PRODUCTION AND MINES

Production in tons, year ended June 30, 1920	4,233
Average annual production, 1916 to 1920	1,858
Total production, 1881 to 1920	155,785

The production in 1920 came from four local mines, two along the Illinois valley bluff near Beardstown, one at Chandlerville, and one at Ashland. These mines are all small, so that the resources of this county are essentially untouched.

COAL-BEARING ROCKS

All of Cass County is underlain by "Coal Measures" strata except for the area between Illinois River and its valley bluff, and in the lower part of the Sangamon valley, below Chandlerville, where the "Coal Measures" have been entirely eroded, so as to expose the underlying Mississippian limestone.

Since the line of outcrop of No. 5 coal nearly coincides with the eastern boundary of the county, it is believed that most of the area is underlain by Pennsylvanian strata older than No. 5 coal, that is by strata of lower Carbondale and Pottsville age. These formations contain at least one and probably two beds of coal neither of which, apparently, is more than three feet thick. The most widespread of these coals is the No. 2 (Colchester, Murphysboro, or La Salle "Third Vein") coal which outcrops along the Illinois and Sangamon valley bluffs between Bluff Springs and Chandlerville, and has been mined at Virginia at a depth of about 200. It is probably this same bed which at one time was mined at Ashland at a depth of 205 feet.[1] As the identity of this coal is not determined, and as it may be younger than No. 2, it may be the same as a bed encountered in a drill hole just south of Springfield, between 50 and 60 feet below No. 5 (Springfield) coal.

The character of the strata with which the coals are interbedded is not well known. Worthen[2] reports the following succession taken at an old shaft near Bluff Springs:

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[1] Third Biennial Report of the Bureau of Labor Statistics, p. 506, 1884.
[2] Geological Survey of Illinois. Vol. 4. p. 165, 1870.

Section of Pennsylvanian strata near Bluff Springs, Cass County

		Thickness *Feet*	Depth *Feet*
1.	Soil (loess)	15	15
2.	Sandstone, brownish, with plant impressions	13	28
3.	Limestone ("blue rock")	2	30
4.	Clay shale ("soapstone")	12	42
5.	Coal	3	45
6.	Fire clay, very hard	4	49

The sandstone, No. 2 of the above section, can be traced along the bluff northeastward nearly to Chandlerville, and it is present in the shaft at Virginia with a thickness of 70 feet, as may be noted in the following drill record of a coal prospect at that place.

Record of a boring for coal at Virginia, Cass County, Illinois[1]

Description of Strata		Thickness		Depth	
		Ft.	*In.*	*Ft.*	*In.*
Quaternary system—					
Pleistocene and Recent—					
Soil, and clay, brown		7	....	7	...
Clay, yellow		2	6	9	6
Clay, blue		29	8	39	2
Hardpan		28	....	67	2
Forest bed (ancient soil)		3	....	70	2
Hardpan		44	10	115	....
Pennsylvanian system—					
Sandstone		71	11	186	11
Limestone, hard		1	1	188	..
Shale, black		2	6	190	6
Shale, clay		10	3	200	9
Coal (No. 2) (base of Pottsville)		3	6	204	3
Fire clay		3	....	207	3
Shale, black		....	3	207	6
Shale, clay		7	6	215	....
Clay, "potter's"		13	....	228	....
Coal		....	2	228	2
Sandstone and shale		6	1	234	3
Coal	Horizon of No. 1	....	3	234	6
Sandstone and shale		6	9	241	3
Coal		....	8	241	11
Sandstone and shale		16	4	258	3
Coal		....	3	258	6
Sandstone		2	9	261	3
Coal		....	2	261	5
Sandstone and shale		3	9	265	2
Clay shale		4	....	269	2

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[1] Geological Survey of Illinois, Vol. 7, p. 15, 1883.

Record of a boring for coal at Virginia, Cass County—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Sandstone	7	5	276	6
Rock, hard siliceous	2	....	278	7
Clay shale	2	6	281	1
Rock, hard siliceous	3	6	284	7
Shale, hard green	2	10	287	5
Mississippian system—				
St. Louis and Warsaw—				
Shale, hard green	2	10	287	5
Limestone	9	1	296	6
Sandstone	1	8	298	2
Limestone	62	4	360	6
Sandstone	8	....	368	6
Limestone, gray	1	....	369	6
Sandstone	2	....	371	6
Limestone	2	3	373	9
Sandstone	18	....	391	9
Keokuk—				
Clay shale, drab	6	6	398	3
Shale, sandy	5	3	403	6
Limestone, shaly	4	1	407	7
Quartz band	....	4	407	11
Limestone, shaly	3	8	411	7
Shale, clay	....	6	412	1
Limestone, shaly	16	9	428	10
Flint band, yellow	....	1	428	11
Shale, clay	3	7	432	6
Limestone, hard gray	4	1	436	7
Limestone, shaly	6	2	442	9
Shale, with bryozoans	2	2	444	11
Limestone, shaly	4	7	449	6

The correlation of the coal mined at Bluff Springs and Virginia is based upon comparisons made by Worthen,[1] who points out the similarity of this coal to the coal mined and outcropping at Exeter, Scott County. Observations by the writer in Scott County indicate that the coal at Exeter and Alsey is the same coal as that mined near Roodhouse and Whitehall in Greene County and at Upper Alton in Madison County, and is to be correlated with the No. 2 coal. This coal in southwestern Illinois has a roof of black paper-shale, commonly called "slate" which has a variable thickness up to about 20 feet; but in certain areas, especially toward the north, gray shale or "soapstone" lies between the coal and "slate." About 5 feet below the coal is a bed of limestone 2 to 5 feet thick, known locally as the "sump rock." These relationships render the identification of the No. 2 coal very definite throughout the southwestern part of the coal basin, so that there is not much doubt as to the correlation of the coal at Bluff Springs, provided it is the same as the coal at Exeter.

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[1] Worthen, A. H. Geological Survey of Illinois, Vol. 4, p. 173.

Dip of the Rocks

In Cass County the coal-bearing strata dip at a low angle to the east, at the rate of 8 to 10 feet per mile. Thus, coal which outcrops along the bluff east of Beardstown is at a depth of about 200 feet at Virginia and, provided the coal formerly mined at Ashland is No. 2, possibly 50 feet lower at Ashland. Because of the eastward dip, younger and younger rocks underlie the glacial material in that direction, so that the outcrop of the No. 5 or Springfield coal nearly coincides with the east line of the county.[1] Whether or not there are large irregularities or significant interruptions in the general eastward dip is not known. In general it is believed unlikely that there are any irregularities in the "lay" of the coal that will seriously interfere with mining.

No. 2 Coal

The principal coal of Cass County is undoubtedly the No. 2 bed, which underlies all the county east of Illinois valley, probably crossing the Sangamon valley near Chandlerville. This coal is commonly between 3 and 3½ feet in thickness, and elsewhere possesses great regularity in thickness and in physical characteristics, though very little is known as to its physical characteristics in this county. It is probable, however, that the coal has the usual gray shale or black "slate" roof found above No. 2 coal in adjacent counties to the south and west, a description of which is given in some detail in the chapter assigned to the resources of Fulton County. An analysis of No. 2 coal made from a sample collected in Schuyler County may also be found in the same section.

Because this coal is relatively so thin and its area of outcrop so small that mining by drift or slope entrance is practicable in only a small part of the county, the development of the coal resources in Cass County is probably not a matter of immediate concern. Diamond drilling should precede future development, as the data available are entirely too meager to justify undertaking mining operations.

As the rock surface below the drift is more or less irregular, it is not improbable that isolated and local areas of No. 5 coal may be present in places in the eastern part of the county, west of the principal line of outcrop.

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[1] Shaw, E. W., and Savage, T. E., U. S. Geological Survey Geol. Atlas: Tallula-Springfield Folio (No. 188), Areal geology sheet, 1913.

The correlation of the coal found between Ashland and Prentice in Morgan County, as shown in the record of drilling near Prentice given below, is uncertain.

Drilling near Prentice, Morgan County

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Pennsylvanian system—				
"Slate," rotten black	2	6	2	6
Coal	....	2	2	8
Fire clay	12	4	15	
Shale	1	....	16	
Coal	....	2	16	2
Fire clay	1	3	16	5
Sandstone and shale	16	7	34	
Shale, with bands of ironstone	56	....	90	
"Slate," black (fossiliferous)	3	10	93	10
Sandstone, soft	15	....	108	10
Shale	14	....	122	10
Limestone	1	....	123	10
"Slate"	2	....	125	10
Coal (No. 2?)	2	10	128	8
Fire clay	6	....	134	8

The stratigraphic succession is more suggestive of strata associated with No. 2 than with any other coal, but such a correlation would possibly give an unusual altitude to the coal at this place.

No analyses of the coal in Cass County are available.

CHRISTIAN COUNTY

Only the northern part of Christian County from Edinburg northward is included in the area of this report. The Greenwood Coal Company at this place mines No. 5 coal. This is the farthest south that this coal is worked in the central part of the State.

Coal-bearing Rocks

The geology of Christian County has been adequately discussed in Illinois Mining Investigations Bulletin 11, Coal Resources of District VII, and no additional data can be added relative to the coal in the northern part of the county. However, the following paragraphs may fitly be quoted from Bulletin 11:

"The coals below No. 6 are lenticular and hence less easily traceable. Moreover, the interval between the beds, especially between No. 5 and No. 6 coals, varies considerably in short distances, thus adding to the difficulty of correlation. For example, the interval between No. 6 coal and the next lower important coal varies from 20 feet in the vicinity of sec. 34, T. 14 N., R. 2 W., to about 75 feet in sec. 13, T. 13 N., R. 2 W. The lower bed ranges in thickness from 1 foot to 5 feet and averages 3½ feet in eight diamond drill holes in the townships mentioned. It is probable that it should be called No. 5 coal since the larger interval is not uncommon in the counties south of Christian, and the smaller one is well known to the north as in the mine at Mechanicsburg. Even at Springfield the average interval between No. 5 and No. 6 coals is but 39 feet. This bed tends to become thicker toward the north, and in secs. 13, 22, 32 and 34, T. 14 N., R. 2 W., No. 5 and No. 6 coals are of about equal importance. In a majority of the holes the roof of No. 5 coal is composed of a few feet of black shale capped by a thin limestone, this succession of beds being the normal one in the Springfield district, where No. 5 coal is mined. Near Edinburg and Sharps the cap-rock is absent.

"* * * Three main horizons appear to exist below No. 5 coal. Owing to the lenticular nature of the coal it is not believed that all three horizons contain commercial coals throughout the county. * * * The lenticular character of (these) coal beds renders predictions unsafe, but the existence of coals that may prove to be commercial, as at Assumption, is highly probable. With this in mind it seems reasonable to suggest that * * * a few holes should be continued from 250 to 300 feet below No. 6 coal in order to test all the possibilities of the area."[1]

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[1] Kay, Fred H. Coal Resources of District VII: Illinois Mining Investigations Bull. 11, pp. 80-81, 1915.

DEWITT COUNTY

INTRODUCTION

DeWitt County lies across the trough of the Illinois coal basin. It is the only county in District IV in which coal has never been mined, nor is coal of workable thickness definitely known to underlie it.

SURFICIAL DEPOSITS

Special attention should be directed to the excessive thickness of the glacial drift which so effectively covers the hard rocks in DeWitt County that "Coal Measures" outcrops are unknown. The few deep drillings that have been made, records of which are reproduced above, show thicknesses of glacial material of from 163 to 350 feet. Leverett[1] states that the average thickness of the drift is probably more than 200 feet. The following data, compiled from Leverett's report, will give some idea of the thickness of the drift at various places in the county.

Thickness of the drift in De Witt County

Town	*Depth of Well*	*Terminal strata*	*Depth of rock entered*
Farmer City (city well)	176	sand	...
Farmer City (coal prospect)	...	...	189
Parnell	200	...	...
Clinton (water wells)	80-100	sand and gravel	...
Clinton (coal boring)	...	...	352
Clinton (coal boring)	...	...	270
Clinton (Barnett's gas well, 8 miles west)	137	sand	...
Hallsville (several gas wells)	117-127	sand	...
Kenney	291	sand and gravel	...
Waynesville (city wells)	150?	...	...
Wapella (water wells.............	80-100	till or sand	...
Maroa (Macon County)	...	...	270

The lower part of the drift commonly contains considerable sand and gravel, and some loose sand or quicksand, which are water-bearing and therefore sources of difficulty to be guarded against in shaft sinking. Furthermore, buried muck and peat beds and associated sands contain inflammable gas derived probably from the muck, and such beds would also probably be a source of considerable inconvenience and risk in opening mines.

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[1] Leverett, Frank, Illinois Glacial Lobe: U. S. Geological Survey Mon. 38, p. 705, 1899.

COAL-BEARING ROCKS

As has been said, coal of workable thickness is not definitely known to underlie DeWitt County. An unsubstantiated record of an old boring at Farmer City reproduced herewith reports 4 feet 4 inches of coal at 564 feet and 4 feet 9 inches at 665 feet. It is possible that the upper of these coals is No. 7, and the lower, No. 5; No. 6 being represented by a 9-inch bed at 606 feet. If the suggested correlations of the coal are correct, it is possible that the limestone beds between 300 and 340 feet represent the Carlinville limestone.

Record of drilling at Farmer City, T. 21 N., R. 5 E., DeWitt County

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Soil	2	....	2	....
Clay, yellow	9	....	11	....
Clay, blue	36	....	47	....
Quicksand	2	....	49	....
Clay, blue, and gravel	6	....	55	....
Clay, blue, and gravel	15	....	70	....
Sand and gravel	40	....	110	....
Clay, blue	6	....	116	....
Sand and gravel	8	....	124	....
Clay, blue, and sand	40	....	164	....
Sand and gravel	10	....	174	....
Quicksand	13	....	187	....
Clay, blue	2	....	189	....
Pennsylvanian system—				
McLeansboro—				
Sandstone	4	....	193	....
Sand shale	11	....	204	....
Shale, red	2	....	206	....
Shale, blue	....	4	206	4
Shale, calcareous	2	8	209	....
Shale, blue	1	....	210	....
Shale, red	8	....	218	....
Shale with limestone seams	2	....	220	....
Sand shale	17	....	237	....
Shale, black	3	....	240	....
Coal	1	2	241	2
Clay shale	39	6	280	8
Clay shale	8	....	288	8
Shale, blue	4	....	292	8
Limestone	8	....	300	8
Shale, black	2	....	302	8
Shale, red and gray	9	....	311	8

Record of drilling at Farmer City—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Limestone	2	....	313	8
Sand shale	5	....	318	8
Limestone	4	....	322	8
Shale, blue	18	....	340	8
Sand shale	10	....	350	8
Shale lime	10	....	360	8
Shale, red	5	....	365	8
Shale, red	6	....	371	8
Sandstone	16	....	388	8
Sandstone, soft	20	....	408	8
Shale, red and gray	7	....	415	8
Sand shale	22	....	437	8
Shale, blue	46	....	483	8
Shale, blue	17	6	501	2
Coal	1	....	502	2
Fire clay	6	6	508	8
Shale, gray	10	....	518	8
Sandstone	6	....	524	8
Sand shale	7	....	531	8
Sandstone	17	....	548	8
Shale, blue	7	....	555	8
Shale, blue	3	....	558	8
Shale, black	1	3	559	11
Shale, gray	2	....	561	11
Shale, black	1	7	563	6
Coal (No. 7?)	4	4	567	10
Fire clay	3	9	571	7
Sandstone	3	....	574	7
Sand shale	6	....	580	7
Shale, blue	15	....	595	7
Shale, gray	4	....	599	7
Shale, bituminous	6	....	605	7
Carbondale—				
Coal (No. 6?)	....	9	606	4
Clay shale	3	3	609	7
Lime shale	6	....	615	7
Shale, blue	10	....	625	7
Sand shale	10	....	635	7
Sand shale	7	....	642	7
Shale, blue	22	9	665	4
Coal (No. 5?)	4	9	669	1
Shale, blue	....	9	669	10

Two deep drillings for oil have been put down in T. 20 N., R. 2. E. (Clinton Township), one in section 10 and the other in section 32. Both records are reproduced herewith, the record of the well in section

10 being copied from the Geological Survey of Illinois, Vol. 8, pages 34 and 35.

Record of drilling in sec. 10, T. 20 N, R. 2 E. (Clinton Township)
DeWitt County

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Surface soil	5	....	5	
Quicksand	15	....	20	
Sand with gravel and boulders	17	....	37	
Sand and clay mixed	53	....	90	
Hardpan	12	....	102	
Gravel	1	....	103	
Hardpan	4	....	107	
Clay and sand	4	....	111	
Gravel and clay	7	....	118	
Hardpan	3	....	121	
Clay and sand	7	....	128	
Clay and gravel	14	....	142	
Clay	4	....	146	
Hardpan	6	....	152	
Clay and gravel	8	....	160	
Quicksand	5	....	165	
Sand and gravel	2	....	167	
Coarse gravel	2	....	169	
Clay	6	....	175	
Gravelly hardpan	25	....	200	
Quicksand	6	....	206	
Sand and clay	7	....	213	
Gravel	9	....	222	
Sand	11	....	233	
Gravel	9	....	242	
Sand	9	....	251	
Quicksand and gravel	101	....	352	
Pennsylvanian system—				
McLeansboro and Carbondale—				
Slate, black	1	....	353	
Fire clay	3	....	356	
Limestone (Lonsdale?)	19	....	375	
Fire clay	1	....	376	
Shale, gray	1	....	377	
Shale, red and gray	10	....	387	
Shale, gray	2	....	389	
Sandstone	36	....	425	
Shale, gray	32	....	457	
Shale, dark	6	....	463	

Record of drilling in sec. 10, T. 20 N., R. 2 E.—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Shale, gray	5	....	468	
Coal (No. 7?)	2	9	470	9
Coal and "slate"	....	9	471	6
Fire clay	7	3	478	9
Limestone	22	....	500	9
Sandstone	6	....	506	9
Clay shale, gray	11	....	517	9
Sandstone	11	....	528	9
Shale, gray	8	....	536	9
Slate, black, and coal	3	....	539	9
Limestone	7	....	546	9
Sandstone	19	....	565	9
Shale, gray	10	....	575	9
"Slate," black	3	....	578	9
"Slate," black and coal	4	....	582	9
Shale, gray	21	....	603	9
"Slate," black	3	....	606	9
Coal (Worthen's No. 3)	1	....	607	9
"Slate," black and trace of coal	2	....	609	9
Clay shale, gray	3	....	612	9
Coal (No. 2?)	1	....	613	9
Pottsville—				
"Slate," black and trace of coal	3	....	616	9
Shale, gray	16	....	632	9
Limestone, hard impure	1	....	633	9
Sandstone, hard	3	....	636	9
Shale, gray	5	....	641	9
"Slate," black	8	....	649	9
Sandstone	10	....	659	9
Shale, gray	3	....	662	9
"Slate," black	2	....	664	9
Shale, gray	8	....	672	9
Shale, sandy	11	....	683	9
Shale, gray	9	....	692	9
Limestone, hard	1	....	693	9
Sandstone, hard	2	....	695	9
Shale, dark	3	....	698	9
Shale, gray	3	....	701	9
Shale, sandy	3	....	704	9
Sandstone	6	....	710	9
"Slate," black, with trace of coal	2	....	712	9
Shale, gray	82	....	792	9
Coal (No. 1?)	1	....	793	9
Shale, gray	10		803	9
Sandstone and shale	25		828	9

Record of C. C. Morris' well near center sec 32, T. 20 N., R. 2 E., DeWitt County

Description of Strata	Thickness		Depth	
	Ft.	in.	Ft.	in.
Quaternary system—				
Pleistocene and Recent—				
Soil	5	....	5	....
Gravel	12	....	17	....
Quicksand	2	....	19	....
Clay and gravel, mixed	13	....	32	....
Clay and gravel, mixed	78	....	110	....
Clay and gravel, mixed	40	....	150	....
Quicksand	20	....	170	....
Hardpan	50	....	220	....
Quicksand	45	....	265	....
Pennsylvanian system—				
Limestone and "slate"	3	....	268	....
"Slate" rock, different color	8	....	276	....
Coal	5	....	281	....
"Slate," changing color	24	....	305	....
Sand	7	....	312	....
"Slate," first red found	12	....	324	....
Shell and "slate"	17	....	341	....
Limestone	7	....	348	....
"Casey oil-bearing strata"	10	....	358	....
"Slate"	19	....	377	....
Limestone, hard	2	....	379	....
"Slate" and coal	4	....	383	....
"Slate"	25	....	408	....
Coal (No. 7?)	6	....	414	....
"Slate" of different color	49	....	463	....
Limestone	3	....	466	....
Sand	4	....	470	....
"Slate"	57	....	527	....
Coal (No. 5?)	2	....	529	....
"Slate," change color	33	....	562	....
Sand "slate"	15	....	577	....
"Slate"	90	....	667	....
Limestone	7	....	674	....
"Slate"	80	....	754	....
"Slate," sandy	12	....	766	....
"Slate," black, no coal	18	....	784	....
Sand, limy	4	....	788	....
"Slate"	16	....	804	....
Sand water	6	....	810	....
"Slate"	19	....	829	....
With oil scum	50	....	879	....
"Slate"	71	....	950	....
Mississippian system—				
"Marble, limy looking"	160	....	1110	....
"Some strange formation"	40	....	1150	....
"Slate"	40	....	1190	....
Shell	3	....	1193	....
"Slate"	7	8	1200	8

Worthen states that the drilling in section 10 was made with the diamond drill, and that it probably penetrated to the base of the "Coal Measures." He tentatively correlates the coal at 468 feet (2 feet 9 inches) with the upper vein (No. 7) in the Bloomington shaft, a record of which is given in the McLean County chapter; and regards the coals at 715 and 721 as possibly equivalent to No. 2 or No. 3, the latter coal not definitely recognized by the present Survey, and the coal at 903 as No. 1. These correlations seem to be consistent with the data assembled since the publication of Worthen's reports. Accordingly, a correlation of the upper coal at Clinton at 468 with the upper coal at Farmer City at 575 seems likely, especially as it is consistent with regional dip toward the trough at the foot of the west slope of the La Salle anticline. The actual difference in altitude may even be slightly more than is indicated by the difference in depth, as the surface altitude at Farmer City is less than at Clinton. It is possible that the limestone at a depth of 356 feet at Clinton is to be correlated with the Lonsdale. If so, the 114-foot interval between the limestone and No. 7 coal is only 25 to 30 feet greater than the usual interval to the north and west.

The log of the boring southwest of Clinton in section 32 is a churn-drill record, and the strata noted do not correspond closely with those reported to have been encountered in the drilling north of Clinton. However, the record is of interest in showing, probably accurately, the depth of the drift and the thickness of the Pennsylvanian; massive Mississippian limestone underlying the "Coal Measures" is entered at 950 feet, about 50 feet below the lower coal in the well north of Clinton. Accordingly it is probable that the well north of Clinton penetrated or nearly penetrated the Pennsylvanian strata at a depth of 942 feet, as suggested by Worthen. Correlations of the coal in the well in section 32 at 410 feet with No. 7 coal, and that at 527 feet with No. 5 is suggested.

STRUCTURE

DeWitt County lies near the center of the trough of the Illinois coal basin, the drilling at Farmer City possibly being approximately along the axis of the trough. It is believed that the strata dip gently eastward toward this trough, possibly at the rate of between 5 to 10 feet per mile. Data are insufficient to show whether or not there are important departures from the general dip. The eastward dip is also slightly modified by a still gentler southward dip of probably not over 5 feet per mile.

COALS

Three workable coals, No. 7, No. 5, and No. 2, possible underlie DeWitt County. The indications are that all the coals are thinner in the central part of the county in the vicinity of Clinton than to the east near Farmer City. The two upper coals are separated by 100 feet of strata and the two lower coals by about 150 to 175 feet of strata, consisting of sandstone and shale with some limestone. These intervals between coals No. 2, No. 5, and No. 7 persist directly northward into La Salle County and District I west of the La Salle anticline. To the northwest, west, and southward the intervals vary.

Further drilling is necessary in order to prove the presence or absence of considerable areas of workable coals in the county and the character of the roof and floor. No. 7 is reported to have a black shale cover at both Clinton and Farmer City, which is similar to conditions reported at Bloomington and farther north in the State. Blue shale is reported above No. 5 coal at Farmer City, and dark shale at Clinton. The coal is commonly capped by black shale elsewhere in the State.

It is possible that the coal resources of this county are large, but such data as are available do not encourage great expectation of large discoveries. Further careful prospecting is essential to a correct understanding of conditions.

FULTON COUNTY

Production and Mines

Production in tons, year ended June 30, 1920	2,331,975
Average annual production, 1916 to 1920	2,367,754
Total production, 1881 to 1920	47,178,407

Fulton County ranked twelfth in 1920, among the coal-producing counties, the output in that fiscal year being between 3 and 4 per cent of the total output of the State.

Table 6 lists the 27 shipping mines operating in 1920.

Besides the shipping mines 131 local or wagon mines also operated in 1920 with a total production of 150,320 tons. All the shipping mines in Fulton County with one exception operate No. 5 coal; the Spoon River Colliery Company, located at Ellisville, operates No. 1 or Rock Island coal. The local banks operate No. 1, No. 2, No. 5, and No. 6 coals, and a coal possibly correctly called No. 3.

Surficial Deposits

The thickness of glacial drift is known to be as much as 155 feet in one place, but the average of 293 wells in the area of the Canton and Avon quadrangles is only 38 feet. The drift consists of glacial stony clay or till with which is commonly associated one or two beds of gravel. Above those a mantle of yellow loess or silt 5 to 20 feet thick covers much of the upland surface, and deposits of alluvium lie in the valleys.

It has been determined from data concerning water wells between Put and Lost Grove creeks, that the drift is thick, so that the outcrop of No. 5 coal lies farther east than is the case south of Put Creek, and north of Lost Grove Creek. The position of this outcrop is indicated on the map, Plate V. This is the only pre-glacial drainage line that has yet been discovered in the county and it is probably the only one within the area underlain by No. 5 coal.

Coal-bearing Rocks.

The general succession of coal-bearing rocks in Fulton County has been indicated to some extent in Part I. It was there stated that because of special field examination in the area of the Avon and Canton quadrangles, which includes nearly all the north half of the county, and also because of the many exposures and coal prospects, knowledge of the coal-bearing rocks in this county is more definite than it is for the other counties in the district. However, as investigations and the commercial mining operations are restricted to the northern part of the county, conditions in the southern part can be less thoroughly described. It is believed that the southern part of the county, a large part of which is remote from a railroad, is probably not underlain by large bodies of the thicker and higher No. 5 and No. 6 coals, but that the lower coals may nevertheless be continuous. It is not improbable, however, that situated near the hill summits there are rather numerous small bodies of the thicker coal which may be suitable for stripping operations and local banks. The determinations of the actual amount of such coal require detailed field investigations which will probably be undertaken a little later. The present report concerns itself, therefore, chiefly with the area in the northeast part of the county underlain by No. 5 coal. The area to the west beyond the outcrop of this coal will receive more detailed description in the proposed report on District III in which coals No. 1 and No. 2 in the western part of the State from Rock Island to Alton will receive special attention. Drill records show that the base of the coal-bearing rocks declines eastward, so that these rocks are thickest in the eastern part of the county. In a deep well at Canton 465 feet of Pennsylvanian and overlying glacial material was penetrated; on the other hand, in the western part of the county near New Philadelphia, the base of the coal-bearing rocks is only 225 feet below the surface.

The youngest Pennsylvanian stratum exposed in the area is the Lonsdale limestone, which underlies the glacial drift in a small area in the northeast part of the county near Farmington. The special significance of this limestone in this study is the fact that its characteristic interval of about 60 feet above No. 7 coal furnishes a basis for the identification of this coal throughout Districts I and III. The limestone underlies a large area in Peoria County where it has been quarried to some extent. In this county No. 7 coal is too thin to be of commercial importance.

No. 6 coal is found outcropping in many places in the county between the outcrop of No. 5 coal and the area underlain by the Lonsdale limestone. It underlies an area of 35 to 40 square miles in the northeast part of the county, extending south from the north line to within two miles of Canton, and west as far as Fairview. It is also present in small areas northeast of Cuba. The approximate outcrop of this coal on the Canton and Avon quadrangles, as determined by Savage, is indicated on the structure map, Plate V. Like all the "Coal Measures" strata, it dips eastward at a low angle. No. 6 (Herrin) coal has in this region, as elsewhere, a limestone cap-rock 3½ to 4 feet thick, separated from the coal by 6 to 14 inches of bluish to dark calcareous shale. The cap-rock contains the fossil found in Illinois only in this stratum, namely, *Girtyina ventricosa.* Savage has identified twenty-two other fossils from this same bed in this county, but none has the value of *Girtyina ventricosa* in identifying the limestone.

The strata between the cap-rock of No. 6 coal and the Lonsdale limestone consist largely of shale. Savage states that overlying the cap-rock of the Herrin coal there is usually 10 to 15 feet of shale, followed by a few feet of sandstone, and which in turn is overlain by about 14 feet of gray and 18 inches of blue shale. No. 7 coal lies 33 to 36 feet above No. 6 coal. Above No. 7 coal is about 40 feet of gray shale, followed by 10 to 12 feet of dark shale which underlies the Lonsdale limestone. It is of some interest that the variegated shales near the horizon of No. 7 coal are found in the Peoria-Springfield areas and are widespread in District VII. They are not known, however, in all districts.

The interval between No. 6 and No. 5 coals varies somewhat in the county. In the northeastern part where the main body of the upper coal lies, the interval is normally about 65 feet. In Putnam Township, however, in the vicinity of Cuba, the interval decreases to such an extent that locally the two coals are thought to be in contact. They have been seen in outcrop within 7½ feet of each other, and one drilling in the vicinity of Cuba found 10 feet of coal. It is thought that this unusual thickness is probably due to lack of intervening strata between the two coal beds, No. 6 lying directly upon No. 5.

The strata between No. 5 and No. 6 consist of a black "slate" above No. 5 coal, 2 to 6 inches, above which is 9 to 20 inches of limestone cap-rock, 12 to 20 inches of soft gray shale or "clod," 20 to 30 feet of gray shale, a variable thickness of sandy shale and sandstone, 6 to 8 feet of yellowish shale, and 1 to 3 feet of the underclay of No. 6 coal. Between the 20- to 30-foot shale member, known as the Canton shale, and the sandy stratum overlying it, is an uneven plane of contact, which results in considerable variation in the thickness of both of these strata. In places, especially in Putnam Township, the Canton shale member is entirely out, so that the sandstone rests on the cap-rock of No. 5 coal or even locally upon the coal itself. Rarely all the strata normally occurring between the Springfield and Herrin coals are wanting, and more rarely a part or all of the No. 5 coal is absent.

The area in which No. 5 and No. 6 are actually in contact is small; and it is only in a small area lying mainly between the line of the Toledo, Peoria, and Western Railroad and Put Creek, in the north half of Putnam Township, that the nearness of No. 5 to No. 6 is especially noteworthy.

No. 5 coal is persistently present in that part of the county east of its line of outcrop. Numerous more or less detached areas of coal probably exist beneath the uplands along the main divides even south of Spoon River, since this coal has been mined at Astoria and in Schuyler County near Rushville. The outcrop of the coal within the Avon and Canton quadrangles is shown in Plate V.

Savage states that the No. 5 coal is uniform in thickness where it is found within the quadrangle, averaging 4 feet 8 inches in 141 well records and 43 measured sections, and generally departing less than 6 inches from the average. In the eastern and northern portions of the county, where the usual sequence of strata overlies this coal, the bed is commonly cut by numerous clay-filled fissures (clay seams or horsebacks), such as are characteristic of this coal in Sangamon County and in other parts of the State. Where sandstone overlies the coal in the vicinity of Cuba, no clay seams have developed. No. 5 coal is commonly correlated by its physical characteristics, especially the presence of horsebacks, and by the physical character of its roof. The black fissile shale containing ironstone or pyritic concretions, ranging from 3 to 4 inches to as many feet in diameter, is the very characteristic roof of the bed, a similar roof not being associated with the other coals. The clod and cap-rock are of local assistance in identifying the coal, but have not the State-wide distribution of the black "slate." The niggerheads, clod, and cap-rock are all fossiliferous, but as they lack definitely identifying forms, do not have the same value in correlation studies as the type fossil of the cap-rock of No. 6 coal. However, they are more or less characteristic.

Although coals below No. 5 are present in Fulton County within the area underlain by No. 5, they are worked only in areas west of the outcrop of this coal. There are two workable coals below No. 5, No. 1 (Rock Island) coal and No. 2 (Colchester or La Salle "Third Vein") coal. No. 2 coal has been worked at Avon; No. 1 is mined at Ellisville and has been worked recently at Seville; at local banks in the western and southern part of the county each of these coals is being worked.

Drilling in the northeastern part of the county, especially in Putnam and Buckheart townships, indicates the probable widespread presence of at least one of these lower coals.

No. 2 (Colchester) coal lies about 90 to 135 feet below No. 5, the lesser interval being found in the Cuba region, and the greater in the northeast part of the county. The strata between No. 5 and No. 2 consist mainly of shale and sandstone, a massive sandstone being rather widespread in the upper third of the section. The roof of No. 2 consists of gray shale or "soapstone" 9 to 14 feet in thickness in the northern and western parts of the county, but thicker toward the south. It is followed above by a black fissile shale 3 to 6 feet thick with which is commonly found a band of fossiliferous, septarian, nodular limestone one-half to one foot thick. Savage states that this is an easily recognized succession which is exposed in many places in the western part of the county. It is noteworthy also that essentially the same succession is found above No. 2 coal in the La Salle district west of the La Salle anticline and in much of District III to the west. The coal has a common thickness of about 2 feet 6 inches, but varies between 2 and 3 feet.

A coal believed to be the equivalent of the coal mined in Rock Island County and known as No. 1 or Rock Island coal, lies 60 to 90 feet below No. 2 coal, the interval being greatest to the east. The area in which this coal is best developed seems to lie west or south of the outcrop of No. 5 coal. The few drill holes to the base of the Pennsylvanian rocks east of the outcrop of No. 5 show coal thick enough to be of commercial value only at the horizon of the Rock Island coal in one or two cores, and these holes are located along the outcrop of the No. 5 coal in Putnam Township. The coal attains locally a thickness of about 4½ feet in the vicinity of Cuba, but there appears to be no large body of it and very commonly the seam is separated by shale partings. Where it is worked in the western part of the county at Ellisville, it is 3 to 5½ feet thick. This coal seems to have been laid down in a narrow trough or basin running north and south through the western part of the State, from Brown to Rock Island County, the eastern edge of which crossed the central part of Fulton County. Its area of main development is therefore west of this district in District III.

No. 1 coal where characteristically developed has a readily recognizable bluish, fossiliferous, limestone cap-rock 5 to 20 feet thick, which is separated from the coal by 6 inches to 3 feet of dark shale. In its typical development this cap rock seems to be restricted to the same area as No. 1 coal, and to become thinner and possibly disappear entirely toward the east. The few drill holes in eastern Fulton County that penetrate No. 1 coal do not find a cap-rock above No. 1 coal.

No. 1 and No. 2 coals will be described in greater detail in a proposed later bulletin which will discuss the coal resources of District III.

Coals between No. 1 and No. 2 seem to be somewhat more numerous in the eastern part of the county than in the western. Between No. 1 and No. 2, lying 20 to 30 feet below No. 2, Savage reports a thin coal, 18 inches thick, which seems to be fairly persistent as it is found in outcrop in the western and central parts of the county and in drilling in the eastern part. Whereas this is the only persistent coal known in the section in the western part of the county where strata outcrop, drilling in the vicinity of Cuba, St. David, and Dunfermline reveals the presence of one or two other coals between No. 2 and No. 1. In the Cuba region the interval between No. 2 and No. 1 coals is about 80 feet. The following record of a hole drilled between Fiatt and Cuba is typical of the succession in that part of the county.

Record of drilling between Fiatt and Cuba See Plate II, No. 1

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Clay	18	....	18	....
Pennsylvanian system—				
Carbondale—				
Sandstone, yellow	10	4	28	4
Slate, dark	1	10	30	2
Coal (No. 5)	4	6	34	8
Shale, light	2	4	37	....
Sandstone, light	2	....	39	....
Shale, mixed	19	....	58	....
Sandstone, light	12	....	70	
Shale, sandy	37	....	107	....
Shale, gray	20	....	127	....
"Slate," dark	1	....	128	
Rock (limestone?), dark	1	....	129	....
Shale, light	14	....	143	....
Coal (No. 2)	2	4	145	2
Pottsville—				
Shale, sandy, light	18	8	164	....
Coal	1	....	165	....
Shale, light, sandy	12	....	177	....
Shale, dark	1	....	178	....
Coal	....	4	178	4

Record of drilling between Fiatt and Cuba—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Shale, light, sandy	18	....	196	4
Shale, dark	7	....	203	4
Coal	....	4	203	8
Sulphur (pyrite)	....	2	203	10
Coal	3	2	207	....
Sandy bottom	....	4	207	4
Rock, boulder (limestone?)	....	8	208	....
Limestone, dark	11	....	219	....
Shale, dark, hard	6	7	225	7
Coal (No. 1)	4	4	229	11
Shale, light, sandy	6	1	236	....

The lower coal with the dark limestone cap-rock is without question No. 1. In the Cuba region rather systematic testing of this coal in certain areas reveals large variations in thickness and character. Its commercial value, therefore, for the present, at least, is small. The limestone cap-rock is commonly about 10 feet in thickness but in places is absent and in other places as thick as 20 feet. The coal overlying the cap-rock or but a short distance above it, is lenticular. In a few holes it has a thickness of about 4 feet, but commonly is less than a foot thick, and so interbedded with shale that it has no value. It is not known just how persistent this bed is in the southern part of the county. It is possible that outcrops of this bed in the vicinity of Lewiston were confused with No. 2 coal by Worthen, resulting in the misinterpretation of the section that appears in his discussion of the geology of Fulton County in Volume IV of the Geological Survey of Illinois.

The two other coals that are fairly continuous in the section, one 12 to 20 or 25 feet below No. 2 coal, and the other about 30 feet lower, are generally thin. In some holes, however, the upper of the two is reported 2 feet or more thick, but it is more commonly found a foot or less in thickness. It is quite possible that this coal outcropping near Lewiston was the one which was confused with No. 2 coal instead of the lower coal as described in the preceding paragraph.

Aside from the limestone and coals noted above, the strata between No. 1 and No. 2 coals are mainly shale, with a sandstone 3 to 8 feet thick rather persistent 17 to 25 feet below No. 2.

STRUCTURE

Geologic structure of the whole of Fulton County has not been determined. A report on the structure based on the altitude of No. 2

coal in the Avon and Canton quadrangles appears in Bulletin 33,[1] and Plate V is a reduction of the maps in that report.

Concerning the structures of the Canton and Avon quadrangles, Savage[2] states:

"In the Colmar region farther west, the oil is found in the upper part of a dome, and in a terrace on its side. Even on this favorable structure, the sand is present only in limited areas. Consequently, any recommendations for test borings for oil in the Avon and Canton area, based on the usual structure features, must be recognized as carrying an unusual amount of uncertainty. However, since it is not possible to tell before borings are made whether the Hoing sand is present or to what extent it is saturated with water in any particular locality, if test borings are to be made, it would seem wise to proceed first on the usual assumption that the rocks will be thoroughly saturated with water, and to test first the places where the structure is favorable, as the highest parts of the anticlines and domes.

"From the structure maps [Plate V] it will be seen that a broad dome is present northwest of Fairview, the highest point of which is in the NE. ¼ sec. 29, and the SE. ¼ sec. 20, T. 8 N., R. 3 E. Southwest of Farmington in secs. 10 and 11, T. 8 N., R. 4 E., there is a low arch in which the beds are somewhat higher than to the north or south.

"From Fiatt a low arch extends toward the southeast corner of the Canton quadrangle. The axis passes about one-half mile north of Jones School, SW. cor. sec. 27, T. 7 N., R. 3 E., and has been traced southeast to the center of sec. 10, T. 6 N., R. 4 E.

"In the northwest quarter of the Avon quadrangle [Plate V], a low anticline is present in the SE. ¼ sec. 14, T. 8 N., R. 1 W. The beds here are somewhat higher than to the west, south, and east; but no outcrops are available toward the north, and the dip in that direction is uncertain. One mile north of Babylon in secs. 11 and the western part of 12, T. 7 N., R. 1 E., the beds are higher than in any other direction except northwest."

The foregoing interpretation of the structure in the Canton and Avon quadrangles was designed to meet inquiries concerning the possible existence of structure favoring oil and gas accumulation in the area. In general such gentle structure does not affect the value of the coal, although knowledge of the structure is of some importance in laying out mines in order to take advantage of the natural slopes for drainage or haulage. However, where regional structure is as gentle as it is here, local variation in the level of the coal may largely offset regional dip, and hence it becomes a distinctly local engineering problem to determine the structure or dip of the coal within each property to be developed. The present maps are of value in determining the general lay or dip of the bed and approximate depth, but should be used guardedly as a basis for laying out mining operations.

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[1] Savage, T. E., Geologic structure of Canton and Avon quadrangles: Illinois State Geological Survey Bull. 33, p. 91, 1917.

[2] Op. cit., p. 99.

On Plate V is included a structure map, which constitutes an appendix to Savage's maps and shows the "lay" of the No. 5 seam in a strip south of the Canton quadrangle, based on detailed drilling and elevation of the surface, as determined by the company. In publishing the map the Survey does not assume the responsibility for the accuracy of these determinations which in all cases do not seem to check closely with the topography on the Canton sheet. However, the map is valuable, especially as it illustrates the slight irregularities that affect the coal and shows how the eastward dip is in places eliminated or even reversed, and hence illustrates the importance of detailed drilling in the accurate determination of the structure prior to laying out properties for mining.

Minor irregularities in the coal beds encountered in mines will be discussed in later paragraphs.

Minable Coals of Eastern Fulton County

The coals of Fulton County known to have present economic value—that is, those that can be profitably worked at this time—are Nos. 6, 5, 2, and 1. Possibly a coal lying between Nos. 1 and 2 may also be workable locally. These coals will be described in the order given.

NO. 6 COAL

DISTRIBUTION AND OCCURRENCE

No. 6 (Herrin or "blue band") coal is present over about 35 to 40 square miles in the northeast part of the county, north of Canton, over a much smaller area north of Cuba. Other small areas not improbably exist, though they are not definitely known to be present. The outcrop of the coal on the Canton quadrangle is shown in the map, Plate V. The area underlain by coal has not been entirely delineated near Cuba. Savage states that the coal lies so near the surface, usually from a few to 50 feet, that its quality has been injured by the action of ground water so that even where it is present the shafts of the commercial mines are put down through this coal to the No. 5 (Springfield) bed which is normally about 65 feet lower.

CHARACTER OF NO. 6 COAL

No. 6 coal in Fulton County is not regarded with as much favor as is No. 5 coal. It is not always possible to tell from a physical examination of a coal bed why the coal is regarded as better or less satisfactory than the coal of an adjacent bed, as the differences are not entirely physical. The relative acceptability of different coals rests largely on the following factors: (1) The amount of ash; (2) the amount of volatile hydrocarbons; (3) the clinkering character of the ash, which is probably the same as the fusibility of the ash; (4) the hardness of the coal, or its ability to withstand handling; and (5) the heat value. For a certain class of users knowledge of the coking quality of the coal is also important. As the coal lies in the bed it is not possible to determine the relative value of the coal with respect to any of the above factors unless it be the amount of ash, and so it is only as a result of experience that judgment can be passed upon the acceptability of a coal.

In general judgment is made on the basis of results attained by the haphazard methods of firing in most steam plants and practically all domestic heaters. Since the fact that popular and careless methods may not be adapted to a coal in question commonly does not enter into the popular judgment, it is quite possible that with better practices in firing and improvements in heating systems coal at present less desirable would eventually come into more popular favor. It is also true that improvements in mining practice particularly in the method of handling the coal at the face, and at the tipple, may largely reduce the differences that exist among coals, especially as concerns the ash content.

The reasons for popular judgment against No. 6 coal and preference for No. 5 are not fully tangible. The general opinion is that this coal is dirtier; that it contains more shale bone, blackjack, and pyrite than No. 5; and that it is smokier, higher in volatile hydrocarbons, and probably somewhat softer, than the lower bed. Some of the prejudice against the upper coal arises from the fact that it lies relatively near the surface and is thought to have suffered somewhat from weathering. A considerable quantity is probably "outcrop" coal, which is usually soft and contains much infiltered clay. Outcrops of No. 6 west of Farmington are usually very poor, especially where the bed lies near the prairie surface, and the coal has a reputation of being generally unsuitable to mine. East of the line of the Chicago, Burlington and Quincy Railroad, between Farmington and Canton, however, along Copperas Creek, the cover is solid and the coal little affected by weathering, except for a few feet immediately along the outcrop. Failure to develop this coal in the shafts between Canton and Farmington is by some laid to the supposed ill effects of weathering, in spite of the fact that it is 50 to 60 feet down. It is possible, however, that the coal was affected somewhat by pre-glacial weathering, as the pre-glacial surface was much nearer the coal than is the present surface.

Where the coal has been observed in adjacent parts of Peoria County the only physical characteristic of the bed which suggests that it might have a value somewhat inferior to that of No. 5 is the rather high ash content, which is indicated by the presence of numerous sulphur balls and by the existence of a continuous blue band. Otherwise the coal does not appear notably different from No. 5 coal. It might justly be argued that the horsebacks of No. 5 coal represent a much more important source of impurities in that coal than do the sulphur balls and blue band in No. 6, so that the prejudice against No. 6 coal is probably based upon qualities not physically displayed in outcrop and at the face in mines.

Analyses and tests show very little difference between No. 5 and No. 6 coals in western Illinois, but whatever difference exists is to the advantage of the lower coal. The No. 6 coal averages about 4 per cent higher in volatile matter on the moisture-free basis, and possibly 2 to 4 per cent higher in moisture. Both coals, however, are relatively high in moisture, varying between 13 and 18 per cent, so that probably the difference in moisture content is of little consequence, and the difference in volatile content likewise hardly warrants favoring one coal more than the other on this score. It is possible, however, the higher coal yields its volatile matter at a lower temperature and hence is less desirable for general use. There is, however, no scientific basis for believing that a difference in the character of the volatile matter exists. Similarly also, whereas the ash of No. 6 coal may be considerably less refractory and hence harder to handle than the ash of No. 5 coal, this has not been scientifically established, and may or may not be a sound basis of difference. So much of the success in handling depends upon the adaptability of the furnace to the coal being used, upon the skill and experience of the fireman, and upon the method of firing that it is always a question until the matter has been authoritatively established, how much basis there is for popular discriminations as between different coals.

Physically No. 6 coal has the usual characteristics of the Illinois coals; namely, it is banded or laminated with alternations of dull and bright coal and occasional mother coal streaks. As a special characteristic of No. 6 coal, there exists a clay or "blue band" about a foot to 15 inches above the base of the bed. This is about 1 to 1½ inches thick and very persistent. Generally the coal is subdivided into three benches, the topmost of which is 12 to 15 inches. Between the top and middle bench is generally a mother coal parting. Commonly the coal has a dark shale roof that is hard to hold, for it generally falls up to the cap-rock, a distance of three feet or less, shortly after the coal is removed. The cap-rock is a 3- to 5-foot limestone, generally solid. The underclay is hard and 1 to 3 feet thick. The expense of moving the roof shale is a handicap against the profitable mining of this coal, although in general roof and floor conditions are not distinctly unfavorable.

NO. 5 COAL

The No. 5 or Springfield bed is the chief source of coal in the shipping mines in Fulton County. Except for a few local mines where No. 6 is worked, it is the only source of coal east of the No. 5 outcrop.

The general physical characteristics of No. 5 coal in Fulton County are similar to those elsewhere in the district, namely, regularity in thickness, common occurrence of clay slips or horsebacks, and a persistent black "slate" roof. Like all Illinois coals, No. 5 is well laminated or banded in structure, and contains lenses, streaks, or partings of mother coal, and occasional masses of bone coal. Balls and lenses of brassy pyrite occur in greater or less fequency, and not uncommonly the coal is "frozen" to the roof by a lens or layer of pyrite. The amount of pyrite varies considerably from mine to mine.

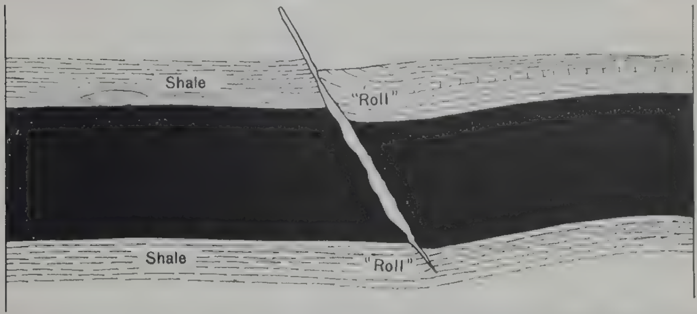

FIG. 5.—Diagrammatic sketch showing the relations of horsebacks to rolls in the roof and floor, and the accompanying faulting.

No physical characteristics peculiar to No. 5 coal in Fulton County distinguish it from the same coal elsewhere in the State. As in other parts of the district there is considerable irregularity in the distribution of the horsebacks, sulphur balls, and other features that detract from the value of the coal in the bed. A few mines in the county are so fortunately located as to be working a block of coal relatively free from impurities. Indeed, one mine reported that any payment to the miners for horsebacks, rolls, or boulders was the exception rather than the rule. In many other mines the extra pay for such irregularities is a serious item of expense. Necessarily this means a great difference in the profits for the various mines in the county. In 1917 the payment for horsebacks amounted to $2.84 for each horseback having an average thickness of 2 to 6 inches in the middle of the bed and 19 cents for each additional inch. In some mines the horsebacks are found as commonly as 12 to 15 feet; in other mines they are very unusual. No good reason has been arrived at for the erratic distribution of the horsebacks.

The horsebacks are usually accompanied by "rolls" in the roof and floor, which also must be paid for when removed. Those in the floor are usually removed, as they are thought to interfere with efficient shooting when left. Their removal is necessary to permit machine-mining. These rolls are apparently of two kinds: (1) In most instances, as in figure 5, faulting as well as fracturing has taken place at the horsebacks, and the coal, roof, and floor, has been offset from a few inches to as much as 18 to 24 inches in places. The upthrow side of the fault in the floor is called a roll in the floor, and the downthrow side of the fault in the roof is called a roll in the roof. In the case of low angle faulting the upthrow side of the floor is directly under the downthrow side of the roof, thereby reducing the apparent thickness of the coal in some places to 3 feet or less. In such instances the roof must be heightened to make head-room for the mules. (2) Rolls also may occur beneath horsebacks where the coal has not been faulted. They are commonly found under rather wide horsebacks and appear to be simply a bulge of the fire clay into the crack to a height of 6 to 12 inches. Rolls of the latter variety are usually small. Rolls are paid for by the inch per running yard.

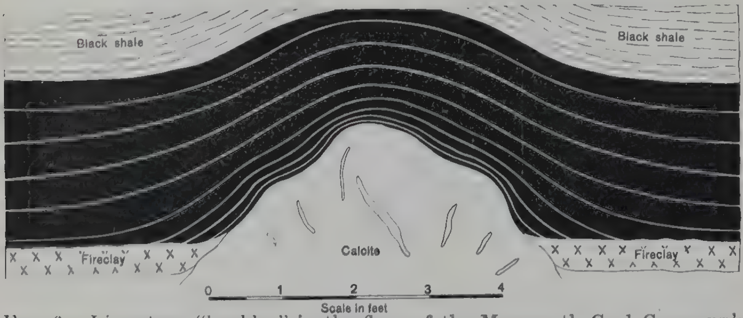

FIG. 6.—Limestone "boulder" in the floor of the Monmouth Coal Company's mine at Brereton.

An additional source of extra expense in some mines in the county consists of the floor "boulders" (fig. 6), which protrude from the fire clay into the bottom of the coal for a maximum distance of about 3 feet. They are commonly less than 2 feet in height in the coal, but may be nearly 3 feet thick, as has been stated, and extend laterally 4 to 5 feet. In 1917 the cost of their removal ran from $2.84 for those 18 to 24 inches high, down to $1.42 for those 6 to 12 inches high. No scale for large ones has been established, as they are uncommon. The boulders are masses of rather waxy-looking, silicified rock, part of a brownish color and part black. Both kinds seem to represent the silicification of woody material. These brownish parts show very distinct wood structure, and appear to be simply petrified. Material of the same character may be calcareous rather than siliceous. The black material, on the other hand, seems to represent silicified peat, or something of that nature, in which the unchanged carbon remains as a residue, making the rock black. The material has the appearance of a very carbonaceous quartzite. Such siliceous boulders are of course very hard and rather difficult to remove.

Some comment should be made upon the occurrence of the "spar" horsebacks that are found in this bed. These are as troublesome if not more troublesome than the clay slips, because they are harder along the immediate position of the fracture and the coal on each side of the fracture commonly contains a wider impregnation of pyrite. They consist merely of veins of pyrite in more or less vertical fractures, entirely resembling the horseback fractures except that they are not as wide and apparently do not extend to as great a distance vertically through the overlying rock. Rarely is the coal bed offset along such spar horsebacks.

The semi-monthly adjustment for horsebacks, rolls, and boulders is an ever-present source of bickerings and misunderstandings between miners and foremen, because of the difficulty in the interpretation of the rules of the agreement. It is exceedingly difficult to ascertain a fair average value for the thickness of a horseback or to accurately measure the size of a roll, especially as the adjustment is usually made after the roll and horseback has been removed from the room or entry and the measurement is made on the cross-section appearing on the rib. A more satisfactory adjustment of this labor problem will obviate much of the difficulty in mining the coal.

Where the coal is undisturbed by irregularities, conditions are relatively favorable for mining. The underclay is hard and generally thin and does not creep readily, so that it rarely causes trouble because of squeezes. The overlying black shale is usually hard and stands well without much timbering after the removal of the coal. Certain difficulties are encountered, however. The niggerheads in the shale, which are occasionally large enough to interfere with operation if left up in a roadway, are heavy and rather difficult to handle. Occasionally one of those left in the roof will loosen and fall. Therefore, to some extent they are a source of possible injury to miner or mule. In some of the mines near Farmington the lower 2 to 3 inches of the "slate" called "draw slate" separates from the main body of the "slate" at what is known as a "false parting" as the coal is removed. When this happens the coal is usually "frozen" to the "draw slate," so that in discarding the "slate" considerable coal, frequently as much as 6 to 8 inches, is thrown into the gob. The "freezing" of coal and "draw slate" is apparently due to a layer of pyrite or pyritized limestone in the top of the coal, the presence of which makes it very difficult to separate the coal from the shale. In one mine where this "draw slate" exists it is reported that its removal is not desired, as the overlying shale is rather difficult to hold. A more desirable condition is to have the coal break away from the roof just below the top of the seam, leaving the sulphur streak in the roof.

In the mines south of Canton and more or less throughout the county, the most serious difficulty arises from the tendency of the "draw slate" to come away with the coal. As long as this lower layer of the shale stays up and the air is kept away from the overlying shale, the roof will remain solid, but once it falls the conditions are almost immediately bad, the shale and overlying clod falling up to the cap-rock. In places even the cap-rock lacks coherence to withstand the strain put upon it when the "slate" falls and the resulting holes in the roof of the mine are expensive to handle.

In one or two mines west of Farmington, a fairly persistent thin "mud seam" occupies a position in the bed about 8 inches below the top. It was reported that in one mine there were several rooms in which the coal had been shot off below this mud seam. It was stated that unless the miner exercises care in placing his holes so that they end above this mud seam, the coal tends to break below it. A similar mud seam lies about 18 inches from the floor in this same mine, and similar care must be taken that the powder holes be driven below the band to insure complete removal of the bed. These bands are not persistent but are very common.

In some of the mines southwest of Canton lying in the bottom of the coal is a band of blackjack, 1 to 3 inches thick, which shoots up with the coal and must all be handled and thrown into the gob. As separation from the coal is not clean, considerable coal is in this way wasted. The blackjack consists of soft carbonaceous shale and coal containing lenses of pyrite up to about 1 inch in thickness and making up about one-fourth of the mass:

MINE NOTES, NO. 5 COAL

ALDEN COAL COMPANY'S MINE NO. 5, AT FARMINGTON

Entrance: Shaft; depth to No. 5 coal, 185 feet.

Thickness of coal: Varies from 3 feet 9 inches to 4 feet 2 inches; averages 4 feet.

Section of the coal:

	Thickness					
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
Roof: Black "slate"						
Coal	3	1½	4	3½	2	1
Sulphur	..	½	..	..	..	1
Coal	..	9¾	..	..	1	10
Floor: Fire Clay	..	..	..	..	..	..
	3	11¾	4	3½	4	0

Character of the coal: The coal is comparatively clean as compared with the same bed in Peoria County. The horsebacks are fairly numerous but rather narrow, commonly not over 4 inches through. About as common as the clay slips are the "spar" horsebacks which are hard and contain crystalline pyrite that fills the crack and ramifies into the coal for several inches on each side, producing a belt of hard coal often nearly 8 inches to a foot wide, through the center of which runs the vertical irregular fissure. "Facings" of pyrite in the joint cracks of the coal are not uncommon. Gypsum or pyrite facings are not common. Clay and mother-coal streaks are rarely more than half an inch thick and are neither continuous, nor especially numerous.

Pyrite in balls or niggerheads is not uncommon. This is pure shiny pyrite apparently of good quality, averaging probably at least 45 per cent sulphur for the hand-cleaned specimen. The masses of pyrite are said to attain a thickness of about 12 inches and to extend for a distance of 5 to 6 feet. None of this size were seen, the largest noted being about 6 inches thick with a lateral extension of possibly 3 to 4 feet. The rooms do not commonly have more than one sulphur ball in the face at one time, averaging possibly 1½ inches thick and 2 inches in diameter. The amount of pyrite actually seen in the face is probably less than 0.5 per cent by weight of the coal.

Character of the roof: The roof is very regular. It consists of the usual succession of black "slate" with niggerheads 8 to 14 inches thick, clod 6 to 8 inches thick, and cap-rock 4 to 8 inches thick. The niggerheads are commonly about 18 inches in diameter, though some are of still larger size. They parallel the bedding of the "slate" and are nearly as thick from top to bottom as is the "slate." These protrude down into the coal and are frequently slick on the surface and lie more or less loosely in the shale, so that they generally drop out. Many are considerably pyritized, some of the smaller ones completely so, but the larger ones for a distance of only about half an inch from the surface. The change from the calcareous center to the pyritic outer layer seems to be direct and not gradual. Ordinarily, however, there is more or less pyrite all through the boulders with an increase in amount toward the pyritic shell.

The lower 2 to 6 inches of the black shale or "slate" is known as the "draw slate." Between it and the overlying shale is what is known as a false parting, along which the two beds separate in places in the mine. More often there is a good parting between the coal and the "draw slate," and the latter does not come away. Where the coal and "draw slate'' stick together, a lens of fossiliferous limestone, for the most part highly pyritized, in most cases lies just at the top of the coal. The limits of pyritization are rather indefinite, extending outward into both the coal and "slate," so as to cause the adherence of the whole mass and the fall of the "draw slate" with the coal when the latter is shot.

Character of the floor: The floor clay in this mine, about which there is nothing unusual, is reported to be about 2 feet thick on the average. It apparently does not heave much. Along entries it is the practice to remove about 10 inches of the floor clay to make headway for the mules.

ALDEN COAL COMPANY'S MINE NO. 6, AT NORRIS

Entrance: Shaft, depth 190 feet to No. 5 coal.

Sections of the coal:

Sections of No 5 coal in the Alden Coal Company's No. 6 mine

	Face entry main west 1900 feet from shaft		2d north off east entry 1200 feet from shaft		Entry face main east 2000 feet from shaft	
	Ft.	*in.*	*Ft.*	*in.*	*Ft*	*in.*
Coal, dull	..	7	..	..	..	4
Coal bright	1	8	4	1	3	8
Coal, dull	..	¼	..	..	..	..
Coal, bright	1	10	..	..	..	..
	4	1¼	4	1	4	0

ASTORIA WOODLAND COAL COMPANY'S ABANDONED MINE

Entrance: Shaft; depth to coal, 58 feet.

Thickness of the coal: Varies from 5 feet to 6¼ feet; averages 5½ feet.

Section of the coal:

Section of No. 5 coal in the NE. entry about 1700 feet from shaft

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal	2	1
Black jack	..	1
Coal	1	..
Mother coal	..	¼
Coal	1	10
Sulphur	..	¼
Coal	..	11
Floor: Fire clay	..	..
	5	11½

The top coal is dark and often broken. At the top of the uppermost of the two 1-foot coals there is commonly a very dark-colored hard cannel-like coal 2 to 3 inches thick. The lowermost of these two coals is soft, and has irregular streaks of sulphur. The bottom bench is a very bright, hard coal. The roof is black shale, more than 3 feet thick, with large nigger-heads or balls of iron pyrite. The floor is fire clay, at least 3 feet thick. The irregularities include large clay veins, some displacing the coal 18 inches. These veins which are exceptionally large, commonly cut entirely through the coal and are as much as 12 feet long and 3 to 4 feet wide.

This property was abandoned in 1910.

BIG CREEK COAL COMPANY'S MINE NO 2, AT ST. DAVID

Entrance: Drift; No. 5 coal.

Thickness of coal: Varies from 4 feet 10 inches to 5 feet 2 inches; averages 5 feet.

Sections of the coal:

Sections 3 to 8 are taken from United States Bureau of Mines Bull. 22, p. 495.

Sections of No. 5 coal in the Big Creek Coal Company's No. 2 (St. David) mine

	(1) 2,200 feet N. W. of drift mouth		(2) 2,500 feet west of drift mouth	
	Thickness			
	Ft.	*in.*	*Ft*	*in.*
Coal	2	..	3	½
Sulphur	..	⅛	..	¼
Coal	..	6	1	7¾
Blackjack	..	⅛	..	..
Shale	..	..	..	2
Coal	1	10¼	..	..
Blackjack	..	1	..	..
Shale	..	2¼	..	..
	4	4½	4	8¼

	(3) Room 3 18th E. 6000 ft. from opening		(4) Entry face 7th W. 4500 ft. from opening		(5) Entry face 15th N. 6000 ft. from opening		(6) Entry face 11th N. 6000 ft. from opening		(7) Entry face 7th E. 5000 ft. from opening		(8) Entry face 14th E. 5500 ft. from opening	
	Thickness											
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
Coal, dull	1	2	1	..	..	8	..	..	..	..	..	9
Sulphur	..	⅛	..	..	..	..	..	..	..	..	..	..
Coal, bright	3	7	4	3	4	..	2	1	4	4	..	..
Coal, dull	..	..	..	..	..	..	..	4	..	..	..	..
Mother coal	..	..	..	..	..	..	..	..	..	..	..	¼
Coal, bright	..	..	..	..	..	..	2	8	..	..	1	11
Sulphur	..	..	..	..	..	..	..	..	..	..	..	⅛
Coal, bright	..	..	..	..	..	..	..	..	..	..	1	10
Total	4	9⅛	5	3	4	8	5	1	4	4	4	6⅜

Character of the coal: The coal bed is uniform throughout, without persistent benches. Small pyrite bands and streaks of mother coal are present. Some gypsum is reported in the facings. At the time the mine was examined in the summer of 1912 the number of horsebacks in the working face was reported as relatively small. In 1908 an earlier observer reported a large number in the mine, which indicates that the coal probably varies considerably as regards frequency of the horsebacks.

Character of the roof: The roof consists of a "draw slate," composed of fine-banded, sandy shale, more or less impregnated with pyrite, 1 to 2 inches thick, black "slate" 2 to 4 feet thick, and a limestone cap-rock. The cap-rock, which is notably persistent, varies in thickness from 6 to 18 inches, but is commonly about 10 inches thick. Its distance above the coal varies from 1 to 4 feet, but is, for the most part, 2 to 2½ feet. The "draw slate" noted above is not a typical "draw slate" as it is usually left up. It probably has about the same characteristics as the "draw slate" observed in mine No. 4 of this company.

Character of the floor: The floor is a hard, bluish-gray clay, 2 feet 6 inches in average thickness. This clay is undercut by mining machines. It heaves somewhat after standing 18 months to two years.

BIG CREEK COAL COMPANY'S MINE NO. 4, AT DUNFERMLINE

Entrance: Shaft; depth to No. 5 coal about 82 feet.

Thickness of coal: Varies from 4½ feet to 5⅓ feet; averages 5 feet 8 inches.

Character of the coal: The coal is very similar to that southwest of Canton. The bed is fairly massive, but to some extent tends to shoot off in benches due to the presence of rather conspicuous but not entirely persistent "dirt" or charcoal bands. Commonly four thin dirt bands lie about 8, 14, 24, and 30 inches from the top, respectively. The coal has distinct horizontal partings and tends to shoot up rather fine. The considerable quantity of mother coal present makes the coal sooty and dirty to handle. A blackjack or clay band about 1½ inches thick is practically continuous. It does not contain the gray sulphur found in the Middleton and Eagle mines near Canton.

Horsebacks are present in about the usual number, but are apparently thinner than they are farther north, so that as a whole they constitute a somewhat less serious difficulty. Pyrite is present in the coal as balls of clean pyrite and to less extent as lenses of grayish laminated pyrite. The balls are most commonly 2½ to 3 inches thick and 8 to 14 inches in diameter, and weigh 20 to 30 pounds. The largest ones, however, may weigh as much as 200 pounds. It is estimated that about one ton of pyrite a day or about one-tenth of one per cent of the total coal mined is uncovered in the coal.

Character of the roof: Roof conditions are similar to those generally found in the mines south and southwest of Canton. The interval between the cap-rock and the coal increases to the south and the cap-rock is somewhat thicker than it is north of Canton. It is more difficult to distinguish the stratum called "draw slate" from the black shale above, as neither does it contain the whitish limy concretions found in the mines farther north, nor are the limestone lenses present which in the mines north of Canton are so commonly found at the top of the coal and the base of the "slate." The parting between coal and "slate" is better than to the north so that the coal breaks away, leaving the "slate" undisturbed. Where the "draw slate" falls, conditions are almost immediately bad, for the black shale and clod (the upper part of the shale) have very little coherence. Over many of the entries the cap-rock is exposed the intervening shale having fallen in. It is higher above the coal than is commonly the case north of Canton, generally being 4 to 5 feet. In places the cap-rock is thin, especially where its lower surface is smooth instead of knobby, as is more frequently the case. The special problem in the mine seems to be that of holding the thin layer of "draw slate'' in the rooms. The main haulageways are commonly brushed up to the cap-rock. The expense of this dead work of course is to be avoided if possible in the rooms.

Character of the floor: When machines are used the coal is cut just above the blackjack band in the base of the coal. In solid shooting the entire bed shoots out and the blackjack must then be cleaned off the coal. The underclay is about 2 feet thick. The floor rolls, as a rule, under the horsebacks.

CANTON COAL MINING COMPANY'S NO. 1 MINE (ABANDONED), SOUTH OF CANTON

Entrance: Shaft; depth to No. 5 coal about 55 feet.

Thickness of the coal: Reported to average 5 feet in thickness.

Section of the coal: In room No. 1 off the third southwest entry the coal was 53 inches thick, and had 2 inches of bone or blackjack at the base. The coal is probably similar to that elsewhere south and southwest of Canton.

EAGLE MINING COMPANY'S MINE AT CANTON

Entrance: Shaft; depth to No. 5 coal 103 feet.

Thickness of the coal: Varies from 4 to 5½ feet; averages 4 feet 11 inches.

Sections of the coal:

Section measured in the Eagle Mine near Canton
1000 feet north-northeast of shaft; face of 4th east entry off the main north entry

	Thickness	
	Ft.	*in.*
Slate	..	10
Coal	4	7½
Dirt band	..	1½
Fire clay	2+	..

Character of the coal: The coal in this mine is representative of the seam south of Canton. It differs from that to the north in being more slabby. Three fairly persistent soot or clay partings, which may vary in position as much as an inch or two each way, lie about 8, 14, and 22 inches from the top, respectively. Commonly a sulphur parting is found

22 to 24 inches from the bottom or about 35 inches from the top, which in places enlarges to become a bright sulphur ball 3 to 6 inches thick. Sulphur lenses and balls are also present here and there in the bed, but are found most frequently in the middle of the bed or up near the roof, and adjacent to horsebacks. In the bottom of the coal is a band of fire clay, coal, and sulphur, 1 to 3 inches thick, called blackjack, which shoots up with the coal and must be cleaned by the miner. The pyrite in the blackjack is of a gray banded variety similar to the brown sulphur found in some of the mines in the Peoria district.

Horsebacks are rather frequent, occurring probably about every twenty feet, but are generally less than 4 inches thick. As elsewhere they are separated from the coal that is loaded out, and a large per cent of the discarded mass is good coal. The waste represented by their removal makes up a considerable but not definitely known per cent of the bed.

Character of the roof: The roof of the seam is the usual black "slate" and clod. The black "slate" is about 10 inches and the clod 14 inches thick. The "draw slate," which is commonly 2 to 3 inches thick and contains numerous small scattered lenses of whitish limestone not larger than ¼ inch by 1 inch, usually stays up. In places an inch or so of the coal stays up in the roof with the "slate," but in other places the coal is separated from the "slate" by a smooth parting. The shale contains a good many niggerheads which tend to fall out, bringing more or less of the shale with them and thereby weakening the roof. When the "draw slate'' comes down and the air gets to the black "slate" and clod, they also generally fall. The cap-rock may or may not be strong enough to hold after the shale has fallen. Roof conditions in this mine are not especially satisfactory; room occasionally have to be abandoned on account of the poor roof conditions.

Character of the floor: The floor consists of the ordinary fire clay and ordinary floor conditions prevail.

EAST CUBA COAL MINING COMPANY'S LOCAL MINE NO. 1 (ABANDONED), AT CUBA

Entrance: Shaft; about 71 feet to No. 5 coal.

Thickness of the coal: Varies from 4 feet 8 inches to 5 feet 4 inches; averages 5 feet.

Sections of the coal:

Section in the mine of the East Cuba Coal Mining Company
Room 1, off 2d east off 1st south off west

	Thickness	
	Ft.	*in.*
Coal	1	11½
Sulphur	..	¼
Coal	..	8¾
Sulphur	..	⅛
Coal	2	..
Sulphur	..	½
Coal	..	1½
Fire clay	4	10½

Character of the coal: Except for the lower 1½ to 2 inches of the coal, which is blackjack, the coal is bright, black, and hard.

Character of the roof: The roof is a black shale 2½ feet thick overlain by six inches of clod or soft gray shale, followed by the cap-rock, which is about 2½ feet thick.

Character of the floor: The floor is gray clay.

Irregularities: The continuity of the bed is broken by what is described as an old stream channel, probably a buried pre-glacial or glacial line of drainage along which the coal has been removed.

MAPLEWOOD COAL COMPANY'S MINE NO. 1, AT FARMINGTON

Entrance: Shaft; about 122 feet to No. 5 coal.

Thickness of coal: Varies from 3 feet 10 inches to 5 feet; averages 4 feet 2 inches.

Character of the coal: The coal is noted as black, shiny, long grain, and uniform from top to bottom. The horsebacks or clay veins are commonly 3 to 6 inches thick, but exceptionally 3 to 4 feet. The smaller veins are the harder.

Character of the roof: The roof consists of 4 inches of black "draw slate," about 24 inches of black shale, and about 10 inches of limestone cap-rock. Above the cap-rock is 15 feet more or less of light sandy shale.

Character of the floor: The floor consists of fire clay 20 inches thick, resting upon a 1-foot limestone layer.

MAPLEWOOD COLLIERY COMPANY'S MINE NO. 2, AT FARMINGTON

Entrance: Shaft; about 146 feet to the top of No. 5 coal.

Thickness of coal: Varies from 3½ to 4 feet; averages 3 feet 9 inches.

Sections of the coal:

Sections in mine No. 2, Maplewood Colliery Company
Section 1—Third south off third west entry

	Thickness	
	Ft.	*in.*
Roof; shale, black, sheety, with niggerheads	..	..
Shale, black, draw	..	4
Coal	4	..
	4	4

Section 2—Face of room 1 off 5th west off north entry, 4,000 feet from shaft

	Thickness	
	Ft.	*in.*
Coal, dull	..	9
Coal, bright	2	11
	3	8

Section 3—Entry rib in the 2d west off main north entry, 3,500 feet from shaft

	Thickness	
	Ft.	*in.*
Coal, dull	1	..
Blackjack	..	¼
Coal, dull	..	9
Blackjack	..	¼
Coal, bright	..	10
Pyrite	..	⅛
Coal, bright	..	4½
Coal, bony	..	½
Coal, bright	..	2
Coal, bony	..	¾
Coal, bright	..	10
	4	1⅞

Character of the coal: The coal has no special peculiarities. It is without benches and conspicuous bedded irregularities. The most persistent banded irregularity is a thin layer of blackjack and pyrite 6 to 8 inches above the base of the coal. The coal is commonly "frozen" to the roof shale, so that it does not come away very evenly.

Character of the roof: The roof consists of 4 to 6 inches of carbonaceous shale or "draw slate," 18 to 30 inches of black shale, and 12 to 18 inches of limestone cap-rock.

Section of the roof of mine No. 2, Maplewood Colliery Company, 700 feet east of the shaft on the main east entry

	Thickness	
	Ft.	*in.*
Shale, carbonaceous, rather soft, with ironstone concretions, about	6	..
Cap-rock; a dark gray limestone with irregular fracture. Bottom of limestone very uneven	1	3
Clod; a black sheety shale with fossil shells	1	2
"Slate;" black, hard, sheety shale with bands of ironstone nodules. Lower 4 inches filled with bands of ironstone, limestone, and pyrite nodules	1	3
Coal	..	..

MONMOUTH COAL COMPANY'S MINE NO. 1, AT NORRIS

Entrance: Shaft; about 142 feet to No. 5 coal.

Thickness of coal: Varies from 4 feet to 4 feet 8 inches; averages 4 feet 4 inches.

Sections of the coal:

Sections of coal in No. 1 mine of Monmouth Coal Company

	(1)		(2)		(3)	
	Entry face 1st E. off S. (16th N.) 4200 ft. from shaft.		23d W. off main south 4500 ft. from shaft.		Entry face 15th S. off 1st west north side 4500 feet from shaft	
	Thicknesses					
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
Coal	4	2	..	..	..	..
Coal, dull	..	..	..	..	..	7
Coal, bright	..	..	2	9	3	9
Sulphur	..	..	..	⅛	..	..
Coal, bright	..	..	1	8	..	..
	4	2	4	5⅛	4	4

Character of the coal: The coal is uniform throughout in general appearance, and does not lie in benches. Streaks of pyrite and mother coal are not uncommon, but for the most part the coal is laminated, bright, and blocky, and is typical for Illinois. The greatest difficulty consists of the horsebacks which average 1 to 2 inches in width and which often contain considerable pyrite.

Character of the roof: The immediate roof is 18 inches to 2 feet of black shale called "slate,'' with a gritty limestone cap-rock about 6 inches thick.

Character of the floor: The floor is fire clay 1 to 1½ feet thick, containing boulders and nodules of pyrite. The boulders in the clay are reported by one observer to be septarian in character, that is, crossed by cracks and containing cavities lined with calcite. The coal is reported to ride over the boulders as shown in the accompanying reproduction of a sketch (fig. 6) made in the northeast part of the mine. The boulders are especially numerous on the north side of the shaft and are also found in the mines at Norris.

STAR COAL COMPANY'S MINE NO. 1, AT FIATT

Entrance: Shaft; depth of No. 5 coal about 56 feet.

Thickness of coal: Varies from 4½ to 5 feet; averages 4 feet 8 inches.

Sections of the coal:

Sections of the coal in mine No. 1 of the Star Coal Company

Section 1—Room face, room 39 off 15th south, off main east

	Thickness	
	Ft.	*in.*
Roof: Black sheety shale containing niggerheads	..	..
Coal: Rather dull and hard with irregular rather than banded appearance. A few vertical irregular veinlets of pyrite, and a little calcite in facings is present and mother coal in slight amount in thickness up to about ¼ inch	4	7
Floor: Fire clay, soft, dark gray; heaves badly in air as well as in water; considerable pyrite in upper two inches	..	..

Sections 2 to 4

	(2) Entry face 20th south 4500 ft. from opening		(3) Entry face 15th south 3500 ft. from opening		(4) Entry face 16th 4000 ft. from opening	
	Thicknesses					
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
Coal, dull	..	10	..	..	..	..
Coal, bright	..	..	4	4	4	3
Mother coal	..	¼	..	..	..	..
Coal, bright	..	6	..	..	..	..
Mother coal	..	½	..	..	..	..
Coal bright	2	..	..	..	..	..
Mother coal	..	½	..	..	..	..
Coal, bright	1	2	..	..	..	..
	4	9	4	4	4	3

Character of the coal: The coal is not subdivided into benches. It is fairly hard, dull in appearance and has hackly fracture and laminated structure. A little pyrite is ordinarily interbedded about 18 inches from the top. There are no clay slips.

Character of the roof: The immediate roof is black "slate" 6 to 20 inches thick, above which is a micaceous sandstone 2 feet or less in thickness. The lower 2 inches of the "slate," called the sulphur band, is crowded with fossils largely pyritized.

Section of roof of No. 5 coal, mine No. 1, of the Star Coal Company, at Fiatt

Section 1—1800 feet from opening on the main east entry

Sandstone.

Soapstone, unconformable in relation to strata below; in places cuts out cap-rock.

Cap-rock; a fine-grained, calcareous and micaceous sandstone, carrying carbonaceous material; thickness up to 6 inches.

Clod; a dark brownish-gray shale with many shells—3 inches.

"Slate;" a black sheety shale, 1 foot 6 inches.

Coal.

Section 2—2500 feet from portal on main east entry

	Thickness	
	Ft.	*in.*
Soapstone; dark gray sandy shale, irregularly bedded, about	4	..
Cap-rock and clod	few inches	
"Slate;" hard black sheety shale	1	3
Shale; sheety, hard, with pyrite	..	4
Coal	..	..

STAR COAL COMPANY'S MINE NO. 3, AT CUBA

Entrance: Shaft; 26 feet to No. 5 coal.

Thickness of coal: Averages 4 feet 8 inches.

Section of the coal:

Section of the coal in mine No. 3 of the Star Coal Company
(Measured in temporary north entry)

	Thickness	
	Ft.	*in.*
Coal	1	9
Parting	..	..
Coal	..	8
"Soot" seam	..	..
Coal	1	8
	4	1

Character of the coal: At the section given above, the coal was uniform in appearance, hard, and rather tough. A narrow vertical sulphur streak lay in the upper part of the bed. Horsebacks are not numerous.

Character of the roof: The roof consists of 2½ feet of black "slate" above which is the cap-rock, about 12 to 18 inches thick.

Character of the floor: The floor consists of fire clay.

MIDDLETON COAL COMPANY'S MIDDLETON MINE, AT CANTON

Entrance: Shaft; 60 feet to the top of No. 5 coal.

Thickness of coal: Varies from 4½ to 5 feet; averages 4 feet 9 inches.

Character of the coal: The coal is separated into poorly distinguished benches by thin clay and mother coal partings, one about 8 inches from the top and another about 1 foot lower. The partings are fairly persistent and the tendency of the coal to break along them must be considered in placing the shots, in order that all the seam may be loosened. A blackjack seam 1 to 3 inches thick at the bottom of the bed is an important impurity. It is composed largely of soft carbonaceous shale and coal with lenses of pyrite up to about 1 inch in thickness making up about one-fourth of the mass. It commonly shoots up with the coal and must be separated by the miner. Considerable coal is wasted in this way. This material makes up the greater part of the gob.

Pyrite is present in the coal as balls of hard, bright "sulphur" and in the blackjack band in a grayer, more earthy form. Sulphur balls were observed at the face of about two-thirds of the rooms and entries visited. They are commonly 2½ by 10 or 12 inches, but in rare cases are 6 inches thick and 3 feet across. A few horsebacks cut the coal, occurring possibly every 50 to 75 feet, but they are not especially troublesome.

Character of the roof: Roof conditions in this mine are somewhat different from those in the mines north of Canton. The "draw slate" is not well differentiated. The coal more commonly breaks smoothly away from the "slate" so that over much of the mine a smooth clean roof is present. In places, however, the coal is "frozen" to the "slate," and coal and slate come away together. This weakens the roof so that eventually it falls even through the cap-rock. Above the cap-rock is a layer of weak clay shale which is called clod, but which is not to be confused with the clod between the black "slate" and cap-rock. Above the upper clod is a gray soapstone. As the shales above the cap-rock carry considerable water, water enters where falls occur.

Character of the floor: The floor is fire clay.

SILVER CREEK COLLIERY COMPANY'S NO. 1 MINE, AT FARMINGTON

Entrance: Shaft; 41 feet to the top of No. 5 coal.

Thickness of coal: Varies from 3 feet to 4 feet 2 inches; averages 4 feet.

Character of the coal: The coal does not lie in benches but contains a few discontinuous thin partings ⅛ to ¼ inch thick, and an occasional nodule of clean, brassy pyrite. Clay and "spar" horsebacks are rather numerous; the removal of this material necessitates extra expense and results in considerable waste. That the amount of bright brassy-looking pyrite is small is indicated by the fact that out of 17 rooms visited, two had one nodule each in the face. One of these was 4 to 6 inches thick and 12 to 15 inches in length, and the other 3 to 4 inches thick and 18 inches across. The amount of pyrite present is rather below the average for the mines of the county.

The peculiar hard masses, called boulders, at the base of the coal, consist of masses of hard brownish rock with a porous texture. Certain of these boulders have the appearance of coke. The material seems to be silicified or calcified wood or peat, as certain fragments show very clearly the wood structure. The character of the replacing mineral varies, some boulders being part silica and part calcite. Further investigation is necessary in order to determine the exact nature of this impurity. One of these boulders measured 14 inches high by about 2 feet across but they vary greatly in size.

Character of the roof: The roof succession, which is similar to that in the other mines of the Farmington region, consists of the "draw slate," "slate," and cap-rock. The behavior of the "draw slate" is uncertain. In places the coal parts freely from the "slate" and the latter stays up, so that slightly less head room is left than is necessary for the mules, and along considerable stretches of the entries about 10 inches of fire clay must be dug up. Commonly, however, the coal sticks to the "draw slate" because a band of pyrite or limestone at the junction of the two strata "freezes" the coal to the "slate." Under these circumstances the "draw slate" comes down with the coal, a condition which is desired even though the coal must then be cleaned off by the miner.

Character of the floor: The floor is fire clay. The layer is about 6 inches in thickness and squeezes up into the entries somewhat where they are wet.

NATIONAL COAL MINING COMPANY'S MINE, WEST OF FARMINGTON

Entrance: Shaft; 105 feet to the top of No. 5 coal.

Thickness of coal: Varies from 3 to 4 feet; averages 3 feet 10 inches.

Character of the coal: The rooms and entries of only the north and west sides were visited. The property adjoins that operated by the Silver Creek Colliery Company on the east and it is probable that conditions in the adjacent parts of the two mines are similar.

At the face the coal displays a slight tendency toward benching. Two "mud" bands a quarter of an inch or less in thickness are commonly present, one about 8 inches from the top and another about 18 inches from the bottom. These are not persistent in the Farmington district, and even in the National mine, are not continuous; but they are reported in at least one other mine. Their presence makes it necessary for the miner to drill his holes so that they end above the upper seam and below the lower; otherwise the middle bench will break away from the upper and lower portions of the bed.

Impurities other than the clay bands noted in the preceding paragraph are not common. Horsebacks of either the clay or "spar" variety seem to be somewhat less common than in most of the mines in the county. The amount of pyrite present in balls and lenses is small. Although no boulders in the bottom of the coal were observed, their occurrence in the adjoining Silver Creek mine would indicate that they may be found or at least expected occasionally in the National mine.

Character of the roof: Roof conditions in general are excellent. The succession is similar to that in other mines in the vicinity, namely, "draw slate," about 3 inches; "slate," 8 to 14 inches, averaging about 10 inches; "clod," about 10 inches; and cap-rock, about 18 inches. In some places pre-glacial erosion channels have cut down nearly to the coal, so that the rock above the seam is only 15 to 20 feet thick. Under such places the roof tends to be weak, so that the rooms cave and let in water. Such falls are the principal difficulty encountered in the mine.

Character of the floor: The floor is fire clay 12 to 18 inches thick and has hard rock below it. The clay heaves but little if any.

GENUINE NORRIS COAL MINING COMPANY'S MINE NO. 1, AT NORRIS

Entrance: Shaft; 180 feet to the top of No. 5 coal.

Thickness of the coal: Varies from 3 feet 9 inches to 4 feet 2 inches; averages 4 feet.

Character of the coal: The coal is without benches, and contains a few streaks of clay and mother coal one-eighth inch or less in thickness, none of them regular, and here and there a pyrite nodule 2 to 3 inches by 6 to 8 inches. These latter are not common. The horsebacks occur in about the usual frequency and size. The impurity most difficult to handle consists of the floor boulders. These are masses of very hard brownish to black rock occupying the lower part of the bed. Some are nearly 3 feet thick and extend laterally 4 to 5 feet. They are similar to the boulders noticed in the mine of the Silver Creek Colliery Company and apparently consist of areas of silicification. Pyrite is present in only relatively small amount as spar sulphur and balls. It is an impurity of little consequence in this mine.

Character of the roof: The usual roof conditions for this area exist. The "draw slate" is persistent. Best mining practice in this mine requires that the "draw slate" remain up, for considerable difficulty is experienced in holding the black "slate" and clod after the "draw slate" falls. The cap-rock seems to be fairly good, but is crossed here and there by incipient cracks which widen on exposure to the air, thereby loosening the rock.

At one locality in the mine along the main south entry, above the black "slate," a massive sandy rock is present which appears to be a very sandy phase of the cap-rock. The sandstone "rolls" down through the clod so that it rests upon the black "slate" within 14 inches of the coal. At this place the coal also dips rather sharply beneath the roll. This is the only structural irregularity, other than the clay or spar slips, that has been noted in the county.

The "draw slate" is a limy black "slate" containing small lenticular bodies of calcareous sandstone or sandy limestone about ⅛ inch thick and 1 inch in diameter. In places it becomes very calcareous and contains lenses of limestone composed of shells which are commonly pyritiferous. The niggerheads seem to be of different origin. They are apparently concretionary and generally not fossiliferous. They seem to be embedded mainly in the black shale or "slate" and to extend down into the "draw slate" or even into the coal.

Character of the floor: The floor is described as fire clay and is said to be about 2 feet thick.

SIMMONS COAL COMPANY'S MINE, AT CANTON

Entrance: Shaft; 121 feet to the top of No. 5 coal.

Thickness of the coal: Varies from 4 to 4½ feet; averages 4 feet 4 inches.

Character of the coal: The coal face was not observed in this mine. The coal is reported to be cut by fewer horsebacks than usual for this area, and the quantity of pyrite is also small. Some bright pyrite in balls is present, however. No boulders in the floor are reported.

The coal bed is interrupted both to the north and south by "faults." They appear to be deposits of sand and gravel made in pre-glacial channels, the floors of which were below the level of the coal.

Character of the roof: The roof is of the usual character. There is generally about 3 inches of "draw slate" present, black "slate" with clod above, about 18 inches thick in all, and the ordinary limestone cap-rock 4 to 10 inches thick.

CRIPPLE CREEK COAL COMPANY'S MINES AT BRYANT

Entrance: Drift; No. 5 coal.

Thickness of the coal: Varies from 4 feet 6 inches to 5 feet 2 inches; averages 4 feet 8 inches.

Character of the coal: The coal lies in benches due to three thin "soot" or mother-coal bands, 8, 22, and 31 inches from the top of the bed respectively. Horsebacks are present but are thin, rarely being more than 2 to 3 inches across. Rolls in the floor are usually less than 6 inches in height. In most of the rooms the coal breaks smoothly ½ to 1 inch below the "slate," leaving a fairly even top, a condition which is rather uncommon for this area. Niggerheads generally work loose and fall out and then the rest of the roof up to the cap-rock falls down. Pyrite is not common.

Character of the roof: The general succession above the coal is the same as in other mines in the area. The black shale and clod above the coal varies in thickness from 3 to 5 feet and the limestone cap-rock is 4 inches or more thick.

COAL BEDS BELOW NO. 5 COAL

In Fulton County the two coals which represent the largest resource are beds No. 2 and No. 1. The former seems to be widespread east of its outcrop. It is thin, but in many records of drilling it varies between 2 feet 6 inches and 3 feet, so that very probably there are large areas that could be profitably mined later if not now. Fortunately the need for the exploitation of such bodies of coal does not exist. No. 2 coal has the usual soapstone or gray shale roof commonly found over this coal in northern Illinois, with a 3-foot bed of black sheety shale at various intervals above the coal, up to possibly about 20 feet. The roof is such as to favor the longwall system of extraction, which is practically always employed where the coal is mined. The bed is usually fairly free from impurities and the coal of somewhat better quality than the coal in the higher beds in the same region.

The lower coal, No. 1 (Rock Island) bed has a much more erratic distribution than have the upper beds. It seems to be fairly persistent, but varies greatly in thickness and is commonly interrupted by lenses of shale which would render it unminable. It is not impossible, although the possibility is gradually being lessened by drilling, that there are areas of sufficient size to be of importance in which No. 1 coal attains a continuous thickness of more than 4 feet. Its normal development, however, is in lenticular bodies, the exploration and outlining of which is expensive, so that it will not be generally undertaken for many years. Furthermore, the roof conditions of this coal are irregular and result in high mining costs. Where it is present close to the coal the limestone cap-rock makes an excellent roof; but too commonly there is a mass of rather loose shale between the coal and the limestone which under present practice must usually be moved. The irregular character of this coal makes possible the discovery of small areas from which large returns can be expected, but for the most part No. 1 probably is not as important a resource as No. 2 coal.

Intermediate thin coals between No. 2 and No. 1, each generally less than a foot thick, locally thicken so as to be workable. Sometime there will no doubt be an eager search for workable areas of these coals, but at present they seem to have no commercial importance.

KNOX COUNTY

Production and Mines

Production in tons year ending June 30, 1920	34,753
Average annual production, 1916-1920	29,387
Total production, 1881-1920	1,866,061

The production of coal from Knox County in 1920 was entirely from wagon or local mines, about three-fourths from No. 6 coal, about one-fourth from No. 5, and a small amount from another bed possibly No. 1. The statistics of labor tabulate 27 mines, of which more than half are drift and slope mines. The county ranked thirty-ninth among the fifty-three producers.

Members of the present Survey have visited only four operations in the county and none of these is now in operation. The outcrop and structure of the various coals have never been determined, and for general geological conditions reliance is placed chiefly upon the report by Worthen in the Geological Survey of Illinois, Vol. IV, pp. 313 to 324. His account of the coals underlying the county is unfortunately confusing because of the wrong identification of at least one and possibly other coals, and because of general uncertainty as to correlation.

Knox and Fulton counties occupy a corresponding position across the outcropping edges of the commercial beds of the State. All the beds of commercial importance except No. 7 and possibly No. 1 outcrop within the county in more or less parallel belts extending north and south. No. 6 lies near the east line and what is possibly No. 1 near the west line. The coal of greatest importance in quantity is probably No. 5. No. 2 probably underlies the largest area, whereas No. 6 is limited to a small area in the eastern part of the county, bounded by its line of outcrop on the west, and No. 1 is limited as a commercial coal in its distribution by its decrease in thickness to the east.

Surficial Deposits

A factor which greatly hinders the development of the considerable amount of outcrop coal in the county is the covering of glacial drift.

The glacial drift is generally but 20 to 30 feet in depth, but in places where valleys have been filled, the depth may reach 100 feet or more.[1]

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[1] Leverett, Frank, Illinois Glacial Lobe: U. S. Geological Survey Mon. 38, p. 676, 1898.

The upper part of the drift is composed of fine yellowish silt or loess, which is somewhat more widespread than the glacial clay or till and is especially effective in concealing outcrops.

The position of the pre-glacial channels which cross the county has not been determined.

COAL-BEARING ROCKS

It is believed that in general the succession of coal bearing rocks in Knox County is the same as in Fulton County eastward, and the coals outcrop in more or less parallel belts extending north and south. No. 6 coal underlies the higher parts of the county south and east of Spoon River, with No. 5 coal outcropping at lower levels. North of Spoon River, No. 6 coal is present on the uplands in the north half of the county as far west as Wataga, Oneida, and possibly Knoxville, but it is probably not generally present south of the Santa Fe Railroad. The area wherein No. 5 coal lies nearest the surface has not been well defined, due to some extent to the confusion in the correlation of this coal. Coal which is described by Worthen[1] as No. 4 is probably No. 5, just as is the case in Fulton County. Other coals, such as that mined at Soperville, which have been called No. 5, are still lacking definite correlation but appear to lie below No. 5 coal. No. 2 coal seems to be the coal nearest the surface in the western part of the county along the Chicago, Burlington and Quincy Railroad, running south from Galesburg through Abingdon and St. Augustine. There are many outcrops of this coal along Spoon River and its tributaries at relatively low altitudes in the county. It is also exposed at a few places near the western edge of the county north of Galesburg. No. 1 coal is possibly of workable thickness along Spoon River valley near the south line of the county, since it is being worked but a short distance south in Fulton County at Ellisville. However, as elsewhere in the State the distribution of this coal is irregular; whether it is generally present in workable thickness is doubtful.

For the general succession in the county we are dependent upon a few records of scattered drilling, the most of which are located in Henderson Township. Other holes have been drilled in Lynn, Galesburg, Copley, Persifer, and Knox townships.

The succession in Henderson Township is illustrated by the following drill records:

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[1] Geological Survey of Illinois, Vol. IV, pp. 312-324.

Record of drilling on the farm of J. Snodgrass in the SW. ¼ NE. ¼ sec. 10, T. 12 N., R. 1 E., Knox County, Illinois.

Estimated elevation about 800 feet above sea level.

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Clay, sandy	20	....	20	
Pennsylvanian system—				
Shale, gray	33	....	53	....
"Slate", dark	2	1	55	1
Coal	1	2	56	3
Shale, gray	2	7	58	10
Sandstone, light	3	2	62	....
Shale, light	2	2	64	2
Sandstone, light	1	4	65	6
Shale, light	15	3	80	9
"Boulder" (limestone?), light	2	2	82	11
Shale, gray	8	1	91	
Shale, sandy brown	30	....	120	
Sandstone, gray	15	4	135	4
Shale, dark	7	11	143	3
Limestone, blue, very hard	2	....	145	3
Shale, dark	7	9	153	....
"Slate," dark	1	11	154	11
Coal	1	7	156	6
Coal, impure (No. 1?)	....	2	156	8
Coal	....	4	157	....
Fire clay	2	....	159	....
Sandstone, white	8	10	167	10
Shale, sandy, light	4	10	172	8
Shale, sandy, gray	7	8	180	4
Shale, sandy, light	5	8	186	....
Coal, soft	1	....	187	....
Shale, sandy, light	2	2	189	2
Shale, lime	4	4	193	6
Sandstone, light	3	10	197	4
Shale, sandy, light	1	4	198	8
Sandstone, light, very hard	4	2	202	10
Shale, sandy, light	7	6	210	4
Shale, gray	2	7	212	11
Coal	1	2	214	1
Shale, gray, sandy	5	11	220	....
Sandstone, gray	....	6	220	5
Shale, dark	1	8	222	2
"Cap rock" (limestone?), very hard	1	1	223	3
Coal, impure	2	4	225	7
Sandstone, gray, hard	....	10	226	5

Record of drilling on the farm of J. Snodgrass—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Sandstone, light, hard	3	3	229	8
Shale, sandy, light	7	4	237	....
Shale, sandy, gray	10	3	247	3
Coal	....	11	248	2
Shale, gray	3	6	251	8
Shale, light gray	4	....	255	8
Shale, sandy, gray	8	1	263	9
Coal	....	3	264	....
Fire clay	1	4	265	4
Shale, sandy, gray	4	1	269	5
Coal	....	2	269	7
Shale, sandy, light	....	10	270	5
Sandstone, light, hard	2	8	273	1
"Slate," dark	10	6	283	7
Sandstone, light, very hard	1	6	285	1
Shale, dark	36	....	321	1
"Slate," dark, hard	15	10	336	11
Sandstone, light, hard	2	6	339	5

Record of a drilling on the H. Smith farm in the SE. ¼ SW. ¼ sec. 16, T. 12 N., R. 1 E., Knox County, Illinois.

Estimated elevation about 750 feet above sea level.

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Clay	26	....	26	....
Sand, gray	35	4	61	4
Sand and gravel	5	....	66	4
Pennsylvanian system—				
Shale, dark	....	6	66	10
Coal	3	1	69	11
Shale, light	6	9	76	8
Coal	....	2	76	10
Shale, sandy, brown	6	2	83	....
Sandstone, dark	7	....	90	....
Sandstone, light	25	....	115	....
Shale, gray, light	3	2	118	2
Shale, dark	8	6	126	8
"Cap-rock" (limestone?)	2	....	128	8
Shale, dark	7	2	135	10
Shale, bituminous	2	3	138	1
Shale, light gray	1	6	139	7
Coal, (No. 1?)	2	3	141	10
"False bottom"	....	4	142	2
Fire clay	1	10	144	....

The identification of the coals in the foregoing records is not definite. The nine holes drilled in the vicinity of Henderson are alike in showing a coal at a depth of 125 to 150 feet which is apparently the coal found at 154 feet 11 inches in the drilling on the Snodgrass farm and at 139 feet 9 inches in the drilling on the Smith farm. The presence of a hard blue limestone cap-rock a few feet above this coal suggests its correlation with No. 1 coal of Mercer and Rock Island counties. It is thought that this same bed is worked at Soperville by T. H. Milan and Company, where the coal is 100 feet below the surface. In this shaft the cap-rock (or "bed rock," as it is called) is about 8 feet above the coal. The seam is from 2 to 4½ feet thick, with an average thickness of about 4 feet. If this is No. 1 coal, then the stratigraphic succession in northwestern Knox County varies from that farther south in that the Pottsville formation is thicker and the Carbondale formation probably thinner to the south and southeast.

It is believed that the coal underlying Henderson Township is certainly below the horizon of No. 5, and accordingly that this part of the county, as well as Rio, Galesburg, Cedar, Indian Point, Orange, and Chestnut townships forms part of District III, in which coals No. 1 and No. 2 are the principal coals mined. They will accordingly be included in the District III report. It is believed that with a small amount of additional field work the correlation of the coals in this part of the county can be satisfactorily settled.

The coals lying below No. 1 or the Soperville coal as shown in the record of the drilling on the Snodgrass farm are not commonly present in Illinois, except possibly in adjacent parts of Henry, Mercer, and Rock Island counties. Except in these counties 200 feet or more of Pottsville is unusual in the northern part of the State. It is possible that locally some of these lower coals may be of workable thickness, but they are not known to be worked in Knox County.

The succession in Galesburg Township is known only from the logs of churn-drill holes for water made by the city. Although these records are of little service in determining the character of the strata, they indicate, however, that the base of the Pennsylvanian strata is at a depth of about 330 feet below the surface at well No. 3. Of this thickness about 80 feet is drift and the remainder probably Pottsville. At Knoxville, in Knox Township, the base of the Pennsylvanian is possibly at a depth of 480 feet, as indicated by the deep water well record.

The following record is that of a diamond-drill hole near Etherly in Copley Township, the exact location of which is not known:

Record of drilling for the Etherly Coal Company, near Etherly, T. 12 N., R. 3 E., Knox County, Illinois.

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Clay, yellow	33	....	33	....
Pennsylvanian system—				
McLeansboro—				
Sandstone	9	....	42	....
Shale, light	3	....	45	....
"Soapstone"	16	....	61	....
Limestone, blue	1	3	62	3
Clay	....	6	62	9
Carbondale—				
Coal (No. 6)	4	2	66	11
Clay	....	6	67	5
"Slate"	7	7	78	....
Limestone	5	....	83	....
"Soapstone"	14	....	97	....
Shale, dark	30	....	127	....
Shale, black	18	....	145	....
"Slate"	6	4	151	4
Coal (No. 5 coal?)	....	11	152	3
"Slate" (No. 5 coal?)	2	....	154	3
Coal (No. 5 coal?)	....	8	154	11
Shale, light	12	1	167	..
Clay	5	....	172	....
Shale, light	34	....	206	....
Limestone	2	....	208	....
Shale, dark	14	....	222	....
Clay, fine	8	....	230	....
"Soapstone," black	17	....	247	....
Limestone	1	....	248	....
"Soapstone," black	2	....	250	....
Limestone	....	4	250	4
"Slate"	5	8	256	....
Clay	....	9	256	9
Coal (No. 2)	3	6	260	3
Pottsville—				
Clay	1	8	261	11
Limestone	....	3	262	2

Of the coals listed above, it is probable that the one at 62 feet 9 inches is No. 6 coal and the one at 256 feet 9 inches, No. 2. No. 5 coal does not seem to be present, though it may be represented by the thin coals at 151 feet 4 inches, and 154 feet 3 inches. The interval between No. 2 and No. 6 in this drilling, namely, 190 feet, is about the same as it is in Fulton County.

A boring near Dahinda in Persifer Township penetrated strata to a depth of 220 feet, beginning apparently about 30 feet above the level of No. 2 coal. No coal was encountered below No. 2. The record is reproduced below.

Record of a boring near Dahinda, Knox County, on the Sargent farm
Drilled 1914

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Clay, sandy	6	....	6	....
Sand and gravel	3	6	9	6
Sand, gray	13	....	22	6
Sand	1	6	24	....
Pennsylvanian system—				
Carbondale?—				
Coal, soft drift	2	8	26	8
Shale, light	3	5	30	1
Coal (No. 2?)	2	9	32	10
Pottsville?—				
Fire clay	2	....	34	10
Sandstone, light	11	7	46	5
Shale, sandy, light gray	14	....	60	5
Shale, light	4	10	65	3
Sandstone, gray	57	8	122	11
Sandstone, light	10	6	133	5
Sandstone, gray	11	....	144	5
Shale, sandy, gray	1	4	145	9
Shale, dark	1	2	147	11
Fire clay	....	9	148	8
Shale, dark	2	1	149	9
Fire clay	4	10	154	7
Shale, sandy, gray	11	2	165	9
Shale, dark	2	....	167	9
Limestone, dark	13	....	180	9
"Slate," dark	1	4	182	1
Shale, light sandy	3	6	185	7
Sandstone, light	4	....	189	7
Sandstone, hard, white	7	2	196	9
Shale, gray	11	2	207	11
Shale, light, sandy	8	....	215	11
Sandstone, light	3	6	219	5
Shale, light, sandy	1	4	220	9

A boring in the extreme northeast corner of the county shows a total thickness of about 420 feet of drift and Pennsylvanian strata. If the record can be relied on, the stratigraphic succession in the locality seems to differ considerably from that in the southern part of the county. Although there is little basis for the correlation of any of the coals, a tentative correlation is suggested in the record which follows:

Record of coal prospect in sec. 1, T. 13 N., R. 4 E, Knox County

Description of Strata	Thickness		Depth	
Quaternary system—	*Ft.*	*in.*	*Ft.*	*in.*
Pleistocene and Recent—				
Clay, gravel and sand	36	----	36	----
Pennsylvanian system—				
McLeansboro—				
Sandstone, gray	9	----	45	
"Slate," gray	9	----	54	
"Slate," dark	42	----	96	----
"Slate," dark, gritty	4	----	100	----
Carbondale—				
Coal (No. 6)	----	4	100	4
Fire clay, blue	2	9	103	1
"Slate," light	2	----	105	1
Sand rock, gray	5	----	110	1
"Slate," light	4	----	114	1
Sand and rock, gray	5	----	119	1
"Slate," light	3	----	122	1
"Slate," gritty, gray	43	----	165	1
"Slate," dark	20	----	185	1
"Slate," mild black	22	8	207	9
"Slate," gritty, blue	4	----	211	9
"Slate," gray	3	9	215	6
Coal (No. 5)	2	6	218	----
Fire clay, light	2	11	220	11
"Slate," gray	5	----	225	11
"Slate," dark	2	----	227	11
Shale, light	11	----	238	11
Sand rock, gray	3	----	241	11
"Slate," light	8	----	249	11
Sand rock, gray	12	----	261	11
"Slate," dark	1	8	263	7
Coal (No. 4)	1	10	265	5
Sand rock, gray	2	6	267	11
"Slate," dark	6	5	274	4
Coal (No. 3)	----	7	274	11
Fire clay, light	3	----	277	11
"Slate," dark	10	----	287	11
"Slate," black	2	----	289	11
"Slate," light	11	----	300	11
"Slate," dark	16	6	317	5
Coal (No. 2)	1	1	318	6

Record of coal prospect in sec. 1, T. 13 N., R. 4 E., Knox County—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Pottsville—				
Fire clay, light	1	5	319	11
"Slate," light	3	....	322	11
Sand rock, light	10	....	332	11
"Slate," dark	12	....	344	11
Coal (No. 1)	....	11	345	10
Fire clay, dark blue	4	1	349	11
Shale, light	3	....	352	11
Rock, hard, gritty, white	4	4	357	3
Lime shale, blue	12	8	369	11

The foregoing represents the information available concerning coal in Knox County, aside from that found in Volume IV of the Geological Survey of Illinois, which may be briefly summerized as follows:

"No. 6 coal is found principally in the eastern half of the county. It varies in thickness from 4 to 6 feet and has a blue band 1½ to 2 feet from the floor. The coal has been worked probably entirely by wagon mines, in T. 13 N., R. 2 E., sec. 36; in T. 12 N., R. 4. E., secs. 4, 5, 17, 18, 19, 29, 30, 31 and 32; in T. 12 N., R. 3 E., secs. 1, 10, 11, 18, 19 and 20; in T. 12 N., R. 2 E., secs. 12, 13, 15, 22, 23 and 24; in T. 11 N., R. 3 E., secs. 3, 4 and 5; in T. 10 N., R. 4 E., sec. 15; in T. 9 N., R. 4 E., secs. 23, 24, 31, and probably 32 and 33; and in T. 9 N., R. 3 E., in sec. 35. The coal has a limestone cap-rock which in places is 4 feet thick.

"The coal is only found in the higher portions of the county, which are principally in the eastern half, and north of Spoon River in the western half of Victoria Township, T. 12 N., R. 4 E., and northwest part of T. 12 N., R. 3 E., Copley Township, and east part of Sparta, T. 12 N., R. 2 E."

No. 5 coal (Worthen No. 4?) lies 40 to 60 feet below No. 6 and commonly varies between 3 and 4 feet in thickness. Mines have been operated in this coal in sec. 25, T. 12 N., R. 4 E., and in secs. 2 and 3, T. 13 N., R. 1 E., possibly along Sugar Creek in T. 12 N., R. 3 E., secs. 9, 16, 32, and along Middle Creek in T. 11 N., R. 2 E., and sec. 25, T. 11 N., R. 1 E., sec. 3, T. 9 N., R. 4 E., and secs. 26 and 27, T. 10 N., R. 4 E.

This coal underlies more of the county than does No. 6; it is probably present in T. 13 N., Rs. 2, 3, and 4 E., and the eastern part of R. 1 E.

No. 2 coal is generally from 1½ to 3 feet thick and of good quality in comparison with other coals in the county. It has been worked in secs. 20, 21, 29, 30, 32, and 33, in T. 12 N., R. 1 E.; in secs. 16 and 23, T. 11 N., R. 2 E.; in secs. 13, 19, 22, 23, and 35, T. 11 N.,

R. 3 E.; at various places in Truro Township, T. 11 N., R. 4 E., along Spoon River; in secs. 8, 16, 19, 29, T. 10 N., R. 3 E.; in secs. 14, 22, 23, 25, 26, 27, 29, 33, 34, T. 10 N., R. 2 E. These operations are by drifting or stripping. There were no shafts to No. 2 when Worthen's report was written in 1870.

No. 1 coal (Worthen correlation) was worked in one place in sec. 21, T. 12 N., R. 1 E., where it is 6 feet thick. It was worked by a shaft 30 feet deep. This is probably the same bed now worked at Soperville.

MINE NOTES

Detailed information about the mines in Knox County is very meager. Four mines have been visited by members of the Survey, none of which is now in operation.

The following data are available concerning these operations:

MINE OF ALBERT WALBURG, KNOXVILLE

Wagon mine.

Entrance: Shaft, 45 feet in depth. Coal mined is probably No. 5. The coal is cut by numerous vertical clay "veins" which pass into the coal, some from the floor and others from the roof. A section of the bed is measured about 300 feet southwest of shaft, as follows:

Section of coal at Walburg mine

	Thickness		Thickness of coal	
	Ft.	*in.*	*Ft.*	*in.*
Roof: Shale, black	2	..		
Sulphur	..	2		
Coal	1	10	2	5
Sulphur	..	½		
Coal	..	6½		
Floor: Fire clay	..	1		

JOHN D. YOUNG MINE, NEAR ABINGDON

Drift mine, operating No. 2 coal, with an average thickness of 2 feet, but varies from 20 to 26 inches. The coal is bright, hard, with brownish streaks. It breaks into cubical pieces, with a conchoidal fracture. Sulphur occurs in irregular lenses at various places in the bed. The following section was measured about 100 feet southeast of entrance:

Section of coal at Young mine

	Thickness		Thickness of coal	
	Ft.	*in.*	*Ft.*	*in.*
Roof: Shale gray	6	..	..	..
Coal	1	3	1	11¾
Sulphur	..	¾		
Coal	..	8		
Floor: Fire clay	3	..	..	..

The roof is fine gray shale, falling in layers 2 to 4 inches thick. It has a thickness of 6 feet or more. The floor is a shale or fire clay at least 3 feet thick.

MINE OF PENDERGAST BROS., AT SOPERVILLE

Entrance: Shaft 120 feet deep, to No. 1 coal. The record of the shaft is as follows:

Record of Pendergast shaft

	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Drift	10	..	10	..
"Soapstone," gray	85	..	95	..
"Slate"	2	6	97	6
Coal	1	10	99	4
Shale, blue	7	..	106	4
Limestone, white, flinty	1	2	107	6
Limestone, bluish	7	..	114	6
Coal (No. 1)	5	..	119	6

This is apparently No. 1 coal of Mercer and Rock Island counties. Another coal, about 40 feet lower, outcrops in places along the creek. The coal was measured in 2d room north, on the east side of shaft about 75 feet east and 100 feet north of opening.

Section of coal in Pendergast mine

	Thickness		Thickness of coal	
	Ft.	*in.*	*Ft.*	*in.*
Roof: Limestone	7	..		
Coal	..	7	3	5⅞
Black jack	..	2		
Coal	2	..		
Sulphur	..	⅜		
Coal	..	8½		
Floor: Fire clay	4	..		

MINE OF GALVA MINING CO., NEAR WATAGA

Shaft mine, 68 feet 6 inches to the floor. Coal averages 4 feet in thickness, varying from 3 feet 4 inches to 4 feet 2 inches. The cap-rock is black to gray shale, 1½ to 4 feet, with a limestone cap-rock 3 feet or more thick. The coal was measured at the 2d north entry about 450 feet from the shaft.

Section of coal in Galva mine

	Thickness		Thickness of coal	
	Ft.	*in.*	*Ft.*	*in.*
Roof: Gray to black shale	1	6+		
Coal	1	2	2	10½
Sulphur and soft shale	..	½		
Coal	..	10		
Shale, soft (blue band?)	22	2		
Coal	..	8		

LOGAN COUNTY

PRODUCTION AND MINES

Production in tons year ending June 3, 1920	2,263,222
Average annual production 1916-1920	452,644
Total production, 1881-1920	10,130,415

Logan County produced a little more than ½ of 1 per cent of the total output for Illinois during the year ending June 30, 1920, and ranked twenty-third in the State. Two mines, both at Lincoln, are now being operated in this county, one by the Latham Lincoln Coal and Mining Company, and the other by the Citizens Coal Mining Company. Table 6 is a list of the shipping mines and data concerning them.

SURFICIAL DEPOSITS

The rock succession in Logan County is known only as it is shown by the records of three drill holes and of three shafts. The drill holes are located at Atlanta and near Lincoln and the shafts at Lincoln and at Mt. Pulaski. One of the drill holes at Atlanta does not enter rock, although it is 151 feet deep.

According to Worthen[1] the outcrops in this county are limited to certain exposures of limestone along Salt Creek in T. 19 N., Rs. 3 and 4 W. Most of the county is thickly covered by drift. In the vicinity of Atlanta the drift has a known thickness of over 200 feet.[2] The character of the material in the drift sheet is shown by the following record of a drilling at Atlanta.

Log of the well at the waterworks at Atlanta, Illinois

Description of strata	Thickness	Depth
Quaternary system—		
Pleistocene and Recent—	*Feet*	*Feet*
Soil, black	3	3
Clay, yellow	15	18
Clay, blue	10	28
Sand and gravel	10	38
Clay, blue	2	40
Sand and gravel	9	49
Clay, white, and sand	7	56
Clay, blue, with gas	3	59
Sand, white, and gravel	10	69
Sand	6	75

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[1] Geology of Illinois, Vol. 4, p. 184, 1870.

[2] Leverett, Frank, Illinois Glacial Lobe: U. S. Geological Survey Mon. 38, pp. 205 and 206, 1899.

Log of the Atlanta well—Concluded

Description of strata	Thickness *Feet*	Depth *Feet*
Sand, dry, and gravel with gas	13	88
Clay, blue	4	92
Clay, sand, gravel, and gas	16	108
Hardpan	9	117
Drift, black	6	123
Clay, white	2	125
Clay, green	4	129
Hardpan	10	139
Gravel and water	12	141

A less detailed record of another boring at Atlanta shows that the drift has a thickness of at least 217 feet in this vicinity.

Record of a coal prospect near Atlanta, Illinois

Description of strata	Thickness *Feet*	Depth *Feet*
Quaternary system—		
Pleistocene and Recent—		
Soil	3	3
Clay, yellow	17	20
Clay, blue	50	70
Hardpan	55	125
Drift, black	8	133
Clay, green	7	140
Hardpan	30	170
Gravel with water	2	172
Gravel and sand, cemented	18	190
Sand and gravel with water	3	193
Clay and gravel and sand	14	207
Loam, yellow	4	211
Sandstone, yellow	1	212
Clay, soft, pink	5	217
Pennsylvanian system—		
"Soapstone"	3	220
Limestone	1	221
Fire clay	3	224
Limestone (?)	53	277
Shale with clay	40	317
"Slate"	7	324
Coal (No. 5?)	4	328
Fire clay	1	329
Limestone	1	330

As the northern part of the county is crossed by a glacial moraine, the drift is thicker there than it is in the southern part. At Lincoln and Mt. Pulaski records show that the glacial covering is generally between 75 and 100 feet deep. Because of the difficulties attendant upon sinking shafts through unconsolidated material the desirability of given areas for mining operations becomes less as the thickness of the drift increases. Accordingly the exploitation of the coal resources of the northern part of Logan County will probably be greatly delayed with respect to the development of the southern part, especially as the character and thickness of the coal is apparently as good in the southern portion as it is in the northern.

COAL-BEARING ROCKS

The character of the coal bearing strata of the county is known from the record of the Atlanta coal prospect given above, and the few outcrops noted above, and from the following records of three other holes:

Record of the shaft of the Citizens Coal Mining Company, Lincoln, Illinois

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Soil and clay	18	....	18	
Drift	3	....	21	
Clay, blue	8	....	29	
Hardpan	16	....	45	
Sand and water	16	....	61	
Sand and hardpan (water)	24	....	85	
Gravel, coarse	3	....	88	
Hardpan	1	5	89	5
Pennsylvanian system—				
McLeansboro—				
Fire clay	3	5	92	10
Limestone, impure	20	....	112	10
Shale, black	1	5	114	3
Fire clay	2	....	116	3
Clay, red and white	12	....	128	3
Fire clay	2	....	130	3
"Conglomerate"	12	....	142	3
"Slate," brown	30	....	172	3
"Slate," black	4	....	176	3
Coal (No. 7)	1	5	177	8
Fire clay	10	....	187	8
Sandstone, blue	22	....	209	8
"Slate," black	1	....	210	8

Record of the shaft of the Citizens Coal Mining Company—Concluded.

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Carbondale—				
Coal (No. 6?)	1	....	211	8
Fire clay	3	5	215	1
Sandstone, blue	18	....	233	1
"Soapstone"	3	....	236	1
Rock, fine blue	7	....	243	1
Shale, blue	18	....	261	1
Limestone	1	6	262	7
"Slate," black	3	4	265	11
Coal (No. 5)	5	2	271	1

Record of a boring for oil in the NE. ¼ sec. 3, T. 19 N., R 2 W., Logan County

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Soil	19	....	19	....
Gravel	20	....	39	....
Quicksand	14	....	53	....
Clay and sand in streaks	18	....	71	....
Pennsylvanian system—				
Limestone, shell	2	....	73	....
Shale, sandy	20	....	93	....
Shale, blue, mucky	8	....	101	....
Quicksand and water	25	....	126	....
Shale (mud), blue	7	....	133	....
Limestone, hard, flinty (Lonsdale?)	12	....	145	....
Shale, red, sandy	15	....	160	....
Shale ("marrow"?), blue	5	....	165	....
Limestone, shell	2	....	167	....
Shale, red	10	....	177	....
Shale ("marrow"?), blue	30	....	207	....
Limestone, shell	2	....	209	....
Shale, white	16	....	225	....
"Slate," blue	4	6	229	6
Limestone, shell	1	....	230	6
Coal, (No. 5)	4	....	234	6
Shale, white	20	....	254	6
Shale, blue	3	6	258	....
Shale, white	20	....	278	....
Limestone, shell	1	....	279	....
Shale, black	7	....	286	....
"Slate," blue	3	....	289	....
"Slate," white	20	....	309	....
Limestone, white; water	10	....	319	....

Record of a boring for oil in the NE. ¼ sec. 3, T. 19 N., R. 2 W., Logan County—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
"Slate," white	101	....	420	....
"Slate," sandy, black	5	....	425	....
Shale, white	98	....	523	....
Shale, blue	2	....	525	....
Shale, white	5	....	530	....
"Slate," black	30	....	560	....
"Slate," white	5	....	565	....
Shale, dark	12	....	577	....
"Slate," white	33	....	610	....
Shale, black	15	....	625	....
Sand, black; gas and water	10	....	635	....
"Slate," white	4	....	639	....
Coal	....	6	639	6
Shale, blue	20	6	660	....
"Slate," white	12	....	672	....
Shale, black, sandy	14	....	686	....
Shale, white	10	....	696	....
Mississippian system—				
Limestone	25	....	721	....
Sandstone	3	....	724	....
"Slate," white; streaks of limestone	18	....	742	....
Limestone	20	....	762	....
Sandstone; salt water	8	....	770	....
Limestone	4	....	774	....
Shale, sandy	5	....	779	....
"Cap rock"	1	6	780	6
Sand, gas	1	6	782	....
"Cap rock"	7	....	789	....
Limestone, hard and soft layers	81	....	870	....
Shale, sandy, dark	3	....	873	....
"Cap rock"	3	....	876	....
Sandstone; salt water	14	....	890	....
"Soapstone"	1	....	891	....
Shale, dark	3	....	894	....
"Cap rock," hard	1	....	895	....
"Cap rock"	2	....	897	....
Sandstone, dark	....	4	897	4
Sandy shale, dark	1	....	898	4
"Cap rock"	1	....	899	4
Sandstone; gas	....	4	899	8
Rock, very hard	8	4	907	....

Record of a coal mine shaft, Mount Pulaski, Illinois[1]

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent				
Drift clay and gravel	92	....	92	....
Pennsylvanian system—				
Shale, sandy	20	....	112	....
Limestone	1	....	113	....
Fire clay	1	6	114	6
"Slate," gray	20	....	134	6
Shale, sandy	40	....	174	6
Limestone	2	....	176	6
Shale, black	1	....	177	6
Coal (No. 8?)	1	6	179	....
Fire clay	2	....	181	....
Shale, clay	4	....	185	....
Shale, gray, sandy	60	....	245	....
Limestone, conglomeratic	15	....	260	....
Shale, clay	2	....	262	....
"Slate," black	1	....	263	....
Coal	....	6	263	6
Fire clay	....	6	264	....
"Slate," black	....	10	264	10
Coal	....	4	265	2
Fire clay	....	8	265	10
Shale, reddish	10	....	275	10
Sandstone	30	....	305	10
Shale, sandy, clay	30	....	335	10
Limestone, black	8	....	343	10
Coal (No. 5)	4	....	347	10
Fire clay	4	....	351	10

The foregoing records differ so much from one another that it is impossible to make a generalization that is of much value in regard to rock succession in the county. The only workable coal in the section, however, seems to be No. 5, at least under present conditions. The only drill hole penetrating the horizon of No. 2 coal is the oil prospect, and as this was drilled by a churn drill, the details are not to be relied upon for accuracy. The absence of a coal which can be correlated with No. 2 in this record is of no great significance.

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[1] Geological Survey of Illinois, Vol. 8, p. 51, 1890.

MINE NOTES

MINE OF THE CITIZENS COAL MINING COMPANY, AT LINCOLN

Entrance: Shaft; 266 feet to the top of No. 5 coal.

Thickness of coal: Averages 5 feet 2 inches; maximum observed, 6 feet.

Character of the coal: The bed lies in a single bench with no persistent partings. It contains a few thin streaks of mother coal or "blackjack" (pyritized mother coal), commonly less than $\frac{1}{16}$ of an inch in thickness. Pyrite lenses and balls are uncommon in the coal. Horsebacks are numerous and vary in width from mere cracks with pyrite filling to openings 3 to 4 inches in width, filled with clay. Rarely the horsebacks or clay slips are as much as 2 feet across. As a general thing the clay veins do not seem to be quite so hard and difficult to handle as are those in some of the mines in the Peoria region. However, the expense of the dead work produced because of the presence of the clay vein is a considerable handicap against the profitable operation of this mine.

Character of the roof: The immediate roof is a black shale which in places is hard and sheety, carrying niggerheads. Over much of the mine, however, the black shale is more massive, softer and thicker, and tends to break out in chunks rather than in sheets. This sort of roof is difficult to hold, especially as the limestone cap-rock is also thin or absent at these places. The cap-rock is a thin gray to whitish limestone, discontinuous in distribution and varying considerably in thickness, but generally present. Where the black "slate" is hard, sheety, and about 3 feet thick, the cap-rock is generally believed to be present, and to be thicker and harder than elsewhere, possibly 12 to 15 inches thick. That this is actually the case must be inferred from the few places where the "slate" has been taken down, as under ordinary conditions it does not fall so that the roof can be seen. Elsewhere the limestone is more clayey, softer, thinner, and in places entirely absent.

Between the coal and the better "slate" roof there is generally a ¾-inch sheet of pyrite, which sticks to the roof rock and remains up. Where the pyrite is present in this manner, the roof is easier to hold; and the absence of the pyrite band generally indicates that roof conditions will be bad.

Character of the floor: Underclay lies beneath the coal. It has not been penetrated but is known to be 5 to 6 feet thick in places. The clay heaves some when it is wet.

The mine encounters some difficulty in handling the water that enters the shaft from a gravel bed 45 to 61 feet from the surface, as shown in the record given above. It is evident that this water was not properly sealed off at the time the shaft was sunk.

MINE OF THE LATHAM LINCOLN COAL COMPANY, AT LINCOLN

Entrance: Shaft; 280 feet to No. 5 coal.

Thickness of coal: Varies from 4 feet 8 inches to 5 feet 3 inches; averages 5 feet.

Sections of the coal:

SECTIONS OF NO. 5 COAL IN MINE OF LATHAM LINCOLN COAL COMPANY, LINCOLN, ILLINOIS

Section 1—Room 3, off first stub off straight south entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean, hard	..	5
Mother coal, soft	..	½
Coal, dirty	2	4
Pyrite	..	⅛
Coal, clean and bright	..	3
Pyrite lens	..	⅞
Coal, dirty, bright	1	10½
	5	0

Section 2—Room 1, off second right off straight east entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean, bright, hard	..	3
Mother coal	..	¼
Coal, fairly clean	2	4½
Mother coal	..	¼
Coal, dirty	..	5¼
Pyrite	..	¼
Coal, very dirty	1	9
	3	10½

Section 3—Room 2, off second stub off third right off north entry [1]

	Thickness	
	Ft.	*in.*
Roof: Black slate	..	..
Pyrite	..	¼
Coal, fairly clean and hard	2	½
Mother coal	..	¼
Coal, dirty	..	2
Pyrite	..	1
Coal, dirty	1	3½
Coal, bony (pyrite and black jack)	..	2½
Coal, very dirty	1	2½
Floor: Underclay	..	..
	5	½

---

[1] U. S. Bureau of Mines Bull. 22, p. 497.

Section 4—1,600 feet N. E. of shaft, room 1, third entry off main cross entry on the northwest side [1]

	Thickness	
	Ft.	*in.*
Roof: Shale	..	..
Coal	..	10
Sulphur	..	½
Coal	3	6
Sulphur	..	⅛
Coal	..	6
Floor: Shale	..	..
	4	10⅝

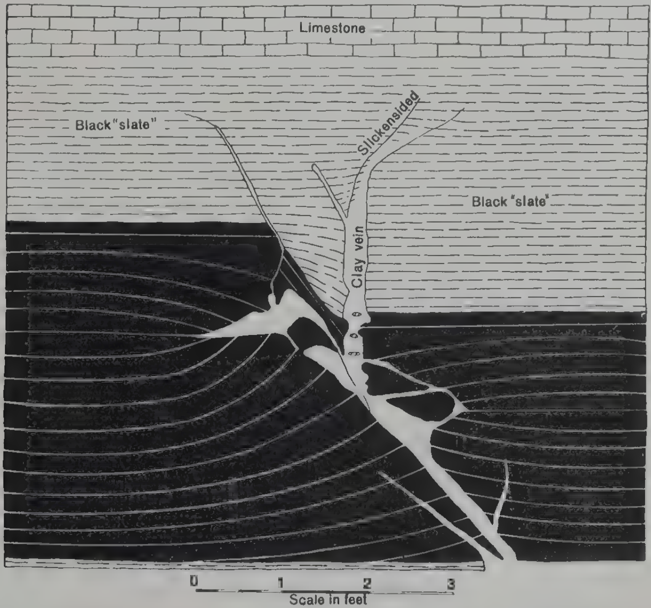

FIG. 7.—Sketch of a clay vein ("horseback") in the Latham-Lincoln Coal Company's mine at Lincoln.

Section 5—1,500 feet southeast of shaft in room 11 off the third south stub

	Thickness	
	Ft.	*in.*
Roof: Shale	..	..
Coal	..	4½
Shale	..	¾
Coal	..	9
Sulphur	..	⅛
Coal	3	8
Floor: Shale	..	..
	4	10⅜

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[1] Op. cit.

Character of the coal: The coal lies in a single bench with no persistent impurities. There are thin mother-coal partings and the lower 2 inches of the bed in places contains bony coal. There is very little pyrite present. Usually also the top 2 inches of the coal is bony. Clay veins or "horsebacks" are rather numerous. The accompanying reproduction of a sketch of one of the clay veins (fig. 7) shows the way in which it plays out in the roof shale.

Character of the roof: The roof is a carbonaceous and sheety black "slate," commonly about 3 feet thick. Above the "slate" is a few inches of dark shale or clod upon which lies the cap-rock. This is a dark-gray fossiliferous limestone, the bottom of which is nodular and uneven. The thickness of the cap-rock averages 8 to 10 inches, but varies from 1 to 18 inches. Overlying the cap-rock there is usually soapstone or gray shale. At the base of the black "slate" and in contact with the coal there is usually a shell of pyrite 2 to 3 inches thick. This generally stays up, forming a good roof. Niggerheads are common along the contact of the coal and "slate."

Character of the floor: The fire clay is said to be 12 feet thick. It slakes in the air and heaves when wet.

MINE OF MT. PULASKI COLLIERY COMPANY (ABANDONED), AT MT. PULASKI, ILLINOIS

Entrance: Shaft 365 feet deep. Figure possibly refers to depth to the top of No. 5 coal.

Thickness of coal: Varies from 3 feet 6 inches to 4 feet 4 inches, averaging 4 feet.

Section of the coal:

Section of No. 5 coal in mine of the Mt. Pulaski Colliery Company, Mt. Pulaski, Illinois

Room 9 off back east entry off main south; 200 feet from shaft

	Thickness	
	Ft.	*in.*
Coal	1	9
Pyrite	..	1½
Coal	1	..
	2	10½

Character of the coal: The coal is all fairly hard and blocky. Pyrite is present in regular streaks but is fairly common. Clay veins or "horsebacks" are numerous, varying in thickness from 2 inches to 2 feet.

Character of the roof: The roof is black "slate" up to 4 feet in thickness.

Character of the floor: The underclay beneath the seam is said to be 10 feet thick. It tends to heave somewhat.

McLEAN COUNTY

Production and Mines

Production in tons, year ending June 30, 1920	43,357
Average production, 1916-1920	71,308
Total production, 1881-1920	5,478,350

McLean County ranked 37th in 1920, having a total production of about 0.05 per cent of the entire output. The output was from one mine, that at Bloomington. The Colfax mine reported no production. Table 6 gives data concerning both mines.

Surficial Deposits

Like most of the counties in central Illinois, McLean County is covered by glacial drift, and in this county its thickness averages probably over 200 feet. Leverett[1] makes the following statement concerning the thickness of the drift:

> "The drift is of great depth, averaging probably over 200 feet. Records of ten deep borings were obtained which reach rock at an average of 155 feet, but twenty-one others have an average depth of 174 feet without entering rock. The drift is apparently thinnest in the northern part of the county, where rock is struck at about 100 feet. The drift in the central and southern portions has a depth of 200 to 250 feet. Buried soils are found at two or more horizons at depths usually of 100 feet or more, but on the plain outside the morainic system a soil occurs at 40 feet or less. The drift above the first buried soil is usually a soft blue till. At greater depths the till is frequently found to be very hard, as in the neighboring counties to the north and northeast, already discussed. In some of the deep borings a large amount of sand and gravel is found in the lower part of the drift. Many wells have been sunk to a depth of 150 to 200 feet in order to reach the water-bearing beds beneath the blue till, there being only a small amount of water-bearing gravel interbedded with the blue till."

Coal-bearing Rocks

Because of the thick covering of glacial material and the consequent lack of outcrops, the geology of the coal-bearing rocks can be determined only by borings or shafts. The only available information of the sort is the record of two drill holes at Saybrook, and three drill or shaft records at Bloomington. The record of a deep boring for oil at Heyworth is too generalized to be of service in these studies.

Such of these records as are not confidential are reproduced herewith.

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[1] Leverett, Frank, Illinois Glacial Lobe: U. S. Geological Survey Mon. 38, p. 693, 1899.

Record of the shaft of the Bloomington Coal Company[1]

Description of Strata	Thickness *Ft.*	Depth *Ft.*
Quaternary system—		
Pleistocene and Recent—		
Surface soil and brown clay	10	10
Clay, blue	40	50
"Hardpan," gravelly	60	110
Mold, black; pieces of wood, etc.	13	123
"Hardpan" and clay	89	212
Mold, black, etc.	6	218
Clay, blue	34	252
Quicksand, buff and drab; fossils	2	254
Pennsylvanian system—		
McLeansboro—		
Shale, clay	16	270
Sandstone	32	302
Shale, clay	1	303
Coal (No. 6 or 7)	4	307

Record of the shaft of the McLean County Coal Company, Bloomington, Illinois.

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Surface soil and gravel	19	7	19	7
Clay, blue	61	2	80	9
Sand (water)	4	----	84	9
Clay, blue	76	4	161	1
Pennsylvanian system—				
McLeansboro and Carbondale—				
"Soapstone"	39	----	200	1
Limestone	1	----	201	1
Clay, blue	35	5	236	6
Clay, yellow	15	10	252	4
Shale	4	----	256	4
Sandstone, soft, gray	11	----	267	4
Limestone, hard, conglomerate	12	6	279	10
"Soapstone"	5	----	284	10
Coal (No. 7?)	3	6	288	4
Fire clay	9	3	297	7
Sandstone, gray	4	----	301	7
"Soapstone"	22	6	324	1
Shale, dark	8	6	332	7
"Soapstone"	9	6	342	1
Fire clay	10	----	352	1

[1] Geol. Survey of Illinois, Vol. IV, pp. 178 and 186.

Record of the shaft of the McLean County Coal Company—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Shale, gray	22	....	374	1
Shale, black ("slate")	5	....	379	1
Coal (No. 5)	4	4	383	5
Fire clay	10	....	393	5
"Slate"	3	....	396	5
Fire clay	4	6	400	11
Sandstone	20	6	421	5
"Soapstone"	62	5	484	10
Shale, black ("slate")	2	7	486	5
Fire clay	1	7	488	....
"Sulphur" rock	1	2	489	2
Shale, gray	11	1	500	3
Shale	1	2	501	5
Limestone, hard	2	1	503	6
Shale, gray	2	8	506	2
"Soapstone"	6	8	512	10
Coal (No. 2)	3	8	516	6
Pottsville—				
"Soapstone," coal, and "slate"	25	....	541	6

Record of a drilling near Saybrook, in the SE. ¼ NW. ¼, sec. 28, T 23 N., R. 6 E.

Description of Strata	Thickness		Depth	
Quaternary system—	*Ft.*	*in.*	*Ft.*	*in.*
Pleistocene and Recent—				
Soil, dark	4	....	4	....
Clay, blue	2	....	6	....
Gravel	2	6	8	6
Clay, blue	20	....	28	6
Clay, blue, with some sand and pebbles	10	....	38	6
Sand, coarse, with some clay	12	....	50	6
Gravel, coarse, mixed with sand	45	....	95	6
Clay, hard, and gravel	55	....	150	6
Quicksand	3	....	153	6
Clay, blue	4	....	157	6
Clay, hard, and gravel	36	6	194	....
Sand and gravel; water	3	....	197	....
Sand, coarse, gray	11	....	208	....
Clay, soft, blue	1	....	209	....
Sand and fine gravel	2	....	211	....
Sand and gravel, cemented	12	....	223	....
Sand, fine, with small boulders	11	....	234	....
Sand, soft	1	6	235	6
Sand, coarse, red	2	6	238	....

Record of drilling near Saybrook—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Pennsylvanian system—				
Sandstone, soft, red	1	....	239	....
Limestone	....	8	239	8
"Soapstone" and shale	10	9	250	5
Shale, black, and coal	....	6	250	11
Shale	16	....	266	11
Limestone	....	7	267	6
Shale, blue	6	6	274	....
Shale, with streaks of limestone	14	....	288	....
Shale, dark	1	....	289	....
"Soapstone"	3	6	292	6
Shale	4	....	296	6
Shale, with spots of limestone	14	....	310	6
Limestone, hard	15	6	326	....
Limestone and shale	8	....	334	....
Shale	19	6	353	6
Shale and sandy shale	51	....	404	6
Shale, blue, tough	8	7	413	1
Shale, soft, in loose layers	7	....	420	1
Shale, black, and coal	....	4	420	5
Coal (No. 7?)	2	6	422	11
Clay, soft	....	8	423	7
Shale, with some sandy shale	94	....	517	7
Sandstone	6	....	523	7
Shale, sandy, gray	2	....	525	7
Shale, black	1	....	526	7
Shale, dark, with limestone bands	5	6	532	1
Limestone, hard, fine	....	6	532	7
Coal (No. 6?)	1	....	533	7
Shale, clay	5	....	538	7
"Soapstone"	3	....	541	7
Shale, clay, bluish	14	....	555	7
Shale, bluish, soft	16	....	571	7
Shale, gray, hard	2	9	574	4
Coal, cannel (No. 5?)	5	4	579	8
Coal	3	....	582	8
Fire clay and shale	6	8	589	4

The interpretation of the records is practicable to a certain extent. The lowest coal at Bloomington, at 512 feet 10 inches, is No. 2 coal, or the same bed that is mined in the Longwall field. The middle bed at 379 feet is No. 5 or Springfield coal. Both of these beds are worked in the McLean County Coal Company's mine at Bloomington. The upper coal at 285 feet is either No. 6 or No. 7 coal, but the probabilities

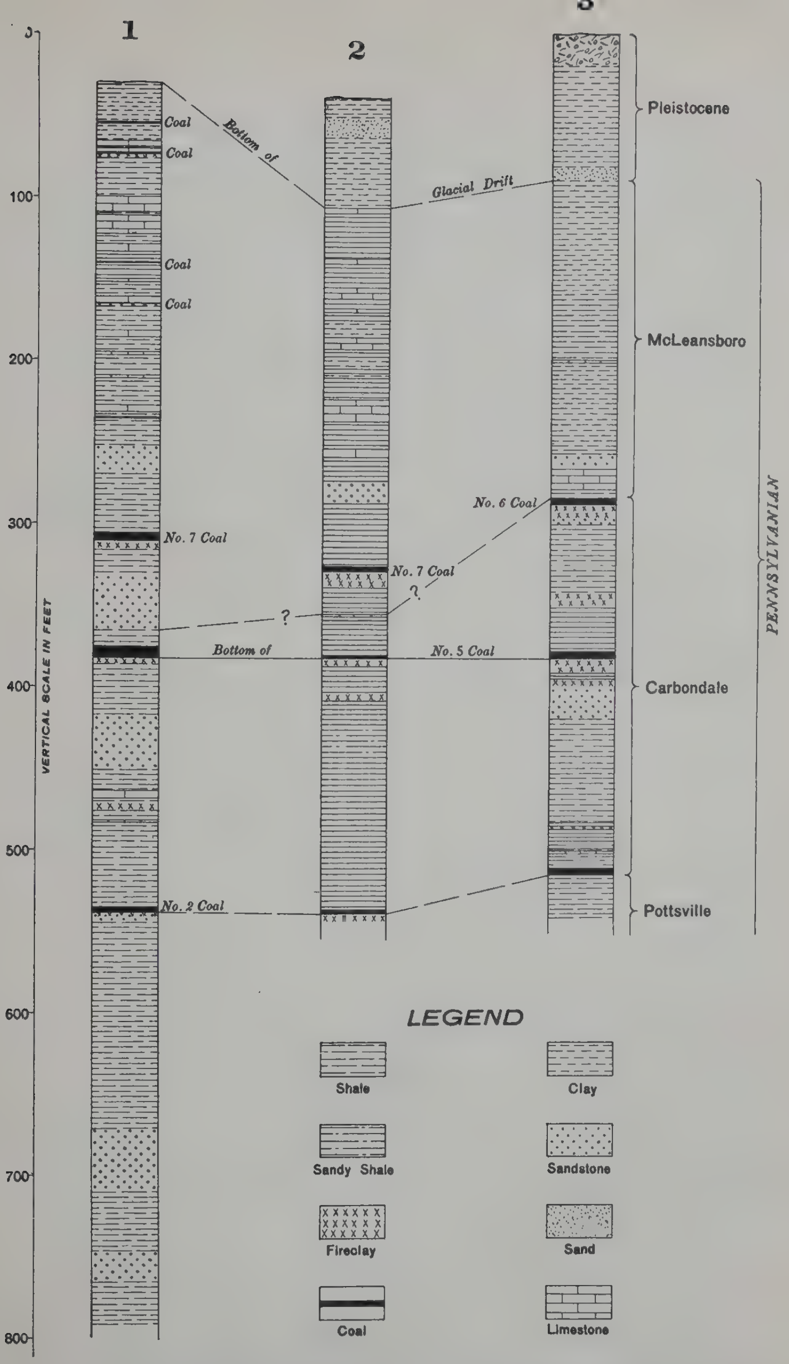

FIG. 8.—Graphic sections showing the Pennsylvanian succession at La Salle, Bloomington, and an intermediate point.

1. La Salle 2. Toluca. 3. Bloomington.

seem to be that it is No. 7, although Worthen regarded it as No. 6. It seems probable that this upper bed is the same as the upper bed at La Salle, which is considered to be No. 7. North from Bloomington the Pennsylvanian section resembles closely the section in the La Salle field west of the La Salle anticline as may be noted from a comparison of the accompanying graphic sections (fig. 8) showing the succession at La Salle, Bloomington, and an intermediate point, Toluca.

The coals encountered in the drilling at Saybrook can not be definitely identified, as neither the thickness nor the intervals between the coals, or the associated strata are characteristic. The writer is inclined to regard the lowermost coal and overlying cannel coal as No. 5 coal, and possibly the other two coals are No. 6 and No. 7, respectively, in their order of occurrence above No. 5. It is unfortunate that the drill did not penetrate to a greater depth, as there is a possibility that there are coals below 590 feet, which can not be proved without exploring the entire thickness of Pennsylvanian strata.

It seems quite probable that McLean County is very largely if not entirely underlain by three workable beds of coal. The upper bed may be eroded in places and is probably not as desirable as are the other two beds. This coal is probably No. 7 of the Illinois section, which is the same as the Streator coal and the upper or First Vein at La Salle. The second bed is the No. 5 or Springfield coal, which is the same as the Second Vein coal at La Salle, formerly mined at Cherry and now mined by the Matthiessen and Hegeler Zinc Company at La Salle. The lowest bed is No. 2 (La Salle) or Third Vein coal.

The coal mined at Colfax is apparently the upper bed, either No. 6 or No. 7.

Field notes are available for two mines in McLean County.

MINE NOTES

MINE OF THE COLFAX COAL COMPANY, AT COLFAX

Entrance: Shaft; 406 feet deep; No. 6? coal.

Thickness of coal: Varies from 4 to 6 feet; averages 5 feet 6 inches.

Section of the coal:

Section of the coal in the mine of the Colfax Coal Company

	Thickness	
	Ft.	*in.*
Roof: Gray shale	..	..
Coal	3	11½
Pyrite and clay	..	¾
Coal	..	11¾
Pyrite	..	1½
Coal	..	4
Floor: Underclay	..	..
	5	5½

Character of the coal: The coal lies in three benches. The bottom coal is bony and dull, with small bands of shale. The middle 11¾ inches has a dull luster with no shale bands; the upper 3 feet 11½ inches is a very bright, glossy hard coal. The seam has no regular bands of sulphur but this impurity is present in irregular lenses.

Although this coal has been designated as No. 6 by the State inspector, it does not possess the identifying characteristics such as the "blue band" and the limestone cap-rock carrying the characteristic fossil *Girtyina ventricosa.* The coal also lacks the characteristics that might correlate it with No. 5, namely, the black shale roof and "horsebacks" or clay slips. The conditions at Colfax possibly resemble those found in the mines at Fairbury and Pontiac, the coal in each of these places being worked under a gray shale roof. However, facts do not warrant a definite correlation of the Colfax coal with that at Fairbury and Pontiac. Furthermore, whether the Pontiac coal should be correlated with No. 5, No. 6, or No. 7, or with any of these coals is a question. The permanent closing of the mine at Colfax will probably make definite correlation of this coal impossible without considerable drilling.

MINE OF THE McLEAN COUNTY COAL COMPANY, AT BLOOMINGTON

Two seams, No. 5 and No. 2, are operated from this shaft.

NO. 2 COAL

Entrance: Shaft; depth to the coal 513 feet.

Thickness of coal: Averages 3 feet 8 inches; the coal maintains a very uniform thickness.

Sections of the coal:

Sections of No. 2 coal in the mine of McLean County Coal Company, at Bloomington

Section 1—Room 21, 5th south off straight west entry

	Thickness	
	Ft.	*in.*
Roof: Gray shale or "soapstone"	..	..
Pyrite	..	½
Coal, clean, hard, and bright	..	9½
Mother coal	..	½
Coal, clean and bright	..	6½
Mother coal	..	¼
Coal, fairly clean	1	3
Bone	..	¼
Coal, dirty	..	5
Floor: Dark underclay	..	..
	3	1½

Section 2—Face of straight west entry, 7,000 feet from shaft

	Thickness Ft.	Thickness in.
Roof: Gray shale	..	..
Coal, clean, bright, hard	1	4
Bone and pyrite	..	¾
Coal, clean, dull, and hard	1	..
Bone	..	¼
Coal, dull, bony	..	6
Floor: Fire clay	..	..
	2	11

Section 5—Room No. 3 off 5th north off main west entry, 7,300 feet from the shaft

	Thickness Ft.	Thickness in.
Roof: Black shale	..	..
Coal, hard, clean, and bright	..	10½
Mother coal and bone	..	½
Coal, clean and hard	..	5
Mother coal	..	¼
Coal, clean and bright	1	1
Bone	..	¾
Coal, soft, dirty	..	6½
Floor: Underclay	..	..
	3	6½

Character of the coal: The coal lies in a single bench. It is hard and tough, but seems to be lighter and cleaner than the upper bed (No. 5). Pyrite balls are rather common, but are easily separated from the coal. There are also lenses of "black jack," which apparently consists of mother coal impregnated with pyrite. These lenses are about as hard as pure pyrite nodules. There is a fairly continuous band of pyrite 4 to 8 inches above the bottom of the bed. This is lenticular in character, the lenses thickening up to about 1 inch. About 1 foot from the top there is a streak of dirty coal 4 to 5 inches thick in part of the mine. The pyrite balls attain a thickness of 6 to 8 inches by 24 inches across, but more commonly they are 1 to 1½ inches thick and 6 to 8 inches across. This coal is said to be dry because it does not "sweat" like the upper coal.

Character of the roof: The typical roof is gray shale, called "soapstone," which is generally about 10 feet thick. In places, however, it has a thickness of 20 feet, and in other places is absent, the black "slate" which elsewhere overlies it resting here upon the coal. The "soapstone" resembles in all respects the shale roof of No. 2 coal noted at La Salle and in the Pottstown mine in Peoria County. It is a fine-grained gray shale, containing small nodules, which weather to a brownish color. The black sheety shale, or "slate," also resembles its counterpart in the La Salle and Peoria regions. It is about 3 feet thick and in places contains large niggerheads or limestone concretions. The coal is reported to be somewhat thinner under the black "slate" than under the gray shale. Where the shale overlies the coal and contains large niggerheads, they may extend well down into the coal, cutting it out in a small area. The coal under the "slate" is spoken of by the miners as being "depressed," as though it had been crushed. There is said to be more pyrite in the coal in this situation; this opinion could not be verified, however, although it may be the case.

The miners speak of the gray shale, overlying the black shale, as the cap-rock. There is no true limestone or sandstone within a short distance above the coal.

Character of the floor: The underclay below the coal is said to have a thickness of about 3 feet. This clay heaves somewhat. The gob from the mine including the floor clay has been used in brick manufacture by a neighboring plant within recent years.

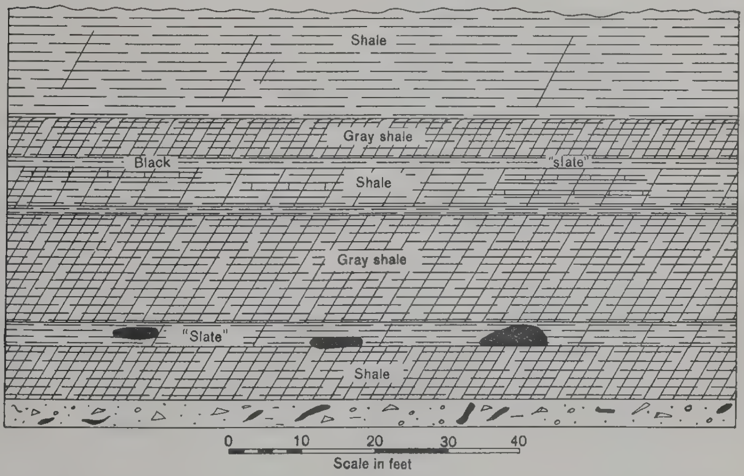

FIG. 9.—Section of the slope between No. 2 and No. 5 coals in the McLean County Company's mine at Bloomington, showing diagrammatically the character of the intervening strata and the cracking resulting from subsidence.

NO. 5 COAL

Entrance: A slope extends from the upper seam to No. 2 coal down which the coal is run to the shaft, where it is hoisted to the top. The bottom of No. 5 coal lies at a depth of 380 feet, according to Worthen,[1] there being an interval of about 130 feet between the two coals. The slope between the beds shows the character of the intervening strata and the effect of subsidence is clearly shown in the walls. The section as measured roughly and the amount of cracking in evidence is given herewith and is shown diagrammatically in Fig. 9.

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[1] Geological Survey of Illinois, Vol. 4, p. 185, 1870.

Section of strata measured in slope between No. 5 and No. 2 coals in mine of the McLean County Coal Company

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Coal (No. 5)	4	....	4	....
Fire clay	2	....	6	....
Shale and sandy shale	12	....	18	....
Shale, black	....	11	18	11
Coal	....	1	19	....
Fire clay	5	....	24	...
Shale, sandy and clay shale	15	....	39	....
Shale, lime; few cracks near bottom	60	....	99	...
Shale, gray, cracked	5	....	104	....
"Slate," black; not cracked	1	....	105	....
Shale, limy; cracked slightly	5	....	110	....
"Slate," black; few cracks	1	....	111	..
Shale, gray (cap-rock); cracked	15	....	126	.
"Slate," black; few cracks	3	....	129	...
Shale; "Soapstone"; cracked	11	....	140	..

The preceding section may be compared with the following log of the shaft between the two coals as given by Worthen.[1]

Section of strata between No. 5 and No. 2 coal encountered in the shaft of the McLean County Coal Company

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Coal (No. 5)	....	....	....	...
Fire clay	10	....	10	...
"Slate"	3	....	13	..
Fire clay	4	6	17	6
Sandstone	20	6	38	...
"Soapstone"	62	5	100	5
Slate, black	2	7	103	...
Fire clay	1	7	104	7
Sulphur rock	1	2	104	9
Slate, gray	11	1	116	10
Shale	1	2	118	....
Limestone, hard	2	1	120	1
Slate, gray	2	8	122	9
"Soapstone"	6	8	129	5
Coal (No. 2)	3	8	133	1

Thickness of coal: Averages about 4 feet, varying from about 3 feet 8 inches to 4 feet 6 inches. The bed maintains a nearly uniform thickness.

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[1] Op. cit.

Sections of the coal:

Sections of No 5 coal in the mine of the McLean County Coal Company, Bloomington, Illinois

Section 1—Face of straight west entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean, hard, bright	1	6½
Pyrite	..	⅛
Coal, clean, bright, hard	..	10½
Pyrite	..	⅛
Coal, clean, bright, hard	..	9
Pyrite	..	⅛
Coal, fairly clean, hard	..	11
	4	1⅜

Section 2—Straight east entry, 600 feet from shaft

	Thickness	
	Ft.	*in.*
Roof: Black "slate"	..	..
Coal, bright	1	8
Sulphur	..	1
Coal, bright	..	5
Sulphur	..	½
Coal, bright	1	4
Sulphur	..	¼
Coal, dull	..	3
Floor: Fire clay	..	..
	3	9¾

Section 3—North side of pillar, 150 feet from shaft

	Thickness	
	Ft.	*in.*
Roof: Black "slate"	..	..
Coal, bright	1	7½
Sulphur	..	¾
Coal, bright	..	4
Sulphur	..	¾
Coal, bright	..	7
Sulphur	..	⅛
Coal	..	2
"Blackjack"	..	½
Coal, bright	..	5
"Blackjack"	..	9
Coal, bright	..	9
Floor: Underclay	..	..
	4	10⅛

Character of the coal: The coal is rather impure because of numerous pyrite streaks and plates, and numerous horsebacks. The pyrite plates are commonly less than a quarter of an inch in thickness and not readily removed from the coal, though an attempt to reject all pyrite is made. None of the pyrite lies persistently at one horizon. The horsebacks are of the usual sort; they are somewhat harder than those found in the Peoria region, however, due to the unusually high pyrite content. Pyrite veins or "spar" veins are also rather common. The coal is also commonly impregnated with pyrite for several inches either side of a clay or "spar" vein, so that the percentage of coal discarded on account of the horsebacks is high. In general, the coal presents no unusual characteristics.

Character of the roof: The immediate roof is a very fine black shale, 1 to 7 inches in thickness, which is almost a cannel coal. The contact between the coal and "slate" is very close, the upper part of the coal and the slate commonly being "frozen" by an intervening layer of pyrite, so that usually the upper 2 to 5 inches of the coal is left in the roof. A persistent layer of nodular limestone about 1½ inches thick lies above the lower black "slate"; overlying this another black "slate" about 11 inches thick, containing streaks of limestone. This is overlain by dark gray shale, which is black when wet and which is called "soapstone." It is between 1 and 2 feet thick and is overlain by a hard gray shale known as the "cap-rock." There is no very good contact between the last-mentioned strata and it is probable that they grade into each other.

Character of the floor: The underclay of No. 5 coal is 2 to 3 feet thick. It has no unusual characteristics.

MACON COUNTY

PRODUCTION AND MINES

Production in tons year ending June 30, 1920	218,820
Average annual production, 1916-1920	252,426
Total production, 1881-1920	10,783,991

In 1920 Macon County ranked twenty-sixth among the counties of the State, having a coal production of about .3 per cent of the entire Illinois output. There were three shipping mines in operation, all working No. 5 coal, two at Decatur, operated by the Macon County Coal Company and the Decatur Coal Company, and one at Niantic, operated by the Niantic Carbon Coal Company. Table 6 lists the shipping mines and gives data concerning them.

COAL-BEARING ROCKS

Lying below a cover of drift, which has an average thickness of 100 feet, are the coal-bearing rocks of Macon County varying in thickness from 800 feet or less to 1,100 feet. They tend to be somewhat thicker to the south than to the north and considerably thicker to the west than to the east. Rock does not outcrop in the county, so that the geology of the coal-bearing strata is known only from drill and shaft records, seventeen in number, most of which are in the vicinity of Decatur.

From the information furnished by these records and the records of holes in adjacent counties, it appears that Macon County lies but a short distance west of the axis of the Illinois coal basin. The strata dip eastward toward the axis, so that No. 6 coal has a depth at Niantic of 310 feet, at Decatur, about 560 feet, and at Lovington in Moultrie County, 900 feet. There is also a slight increase in depth southward through the county, but it is less than the increase to the east. The eastward dip of the rock effects a thickening of the Pennsylvanian system in that direction, as noted above, and younger and younger rock underlies the drift toward the east. It is probable that the New Haven limestone, commonly found about 600 feet above No. 6 coal, outcrops below the drift in a belt running approximately north and south in eastern Macon County or western Moultrie County.

The Carlinville and Shoal Creek limestones possibly outcrop below the drift in parallel belts in western Macon County west of Niantic. One of these limestones, probably the Shoal Creek, underlies the drift in the shaft at Niantic. It seems probable, therefore, that the Pennsylvanian rock below the drift includes strata lying between the horizon of the Carlinville limestone and strata adjacent to the New Haven limestone; that is, between about 300 and about 600 feet above No. 6 coal.

In Macon County the occurrence and distribution of the coals are somewhat similar to the occurrence and distribution in Sangamon County, which lies adjacent in District VII. In the extreme southern part of the county No. 6 is probably present in commercial thickness, but as far south as Moweaqua, Shelby County, No. 5 coal is possibly of as great or greater importance. In the northern part of the county No. 6 coal plays out, so that only No. 5 coal can be mined. Thus a thinning of No. 6 comparable to the thinning of that coal in Sangamon County exists in Macon County.

No. 2 coal in a thickness not known to exceed 2½ feet, is probably present 150 to 175 feet below No. 5. No. 1 coal, mined at Assumption in Christian County, is also present, possibly generally, about 100 feet below No. 2, with a maximum known thickness in the county of about 3 feet. It is doubtful whether either of the lower coals is at present of workable thickness in competition with the thicker overlying beds.

The following records, together with the Blue Mound record given in Part I, will aid the driller and prospector in identifying beds in Macon County.

Log of air shaft at Decatur, about one-half mile southwest of the coal shaft near bluffs of the Sangamon river[1], *sec. 14?, T. 16 N., R. 2 E.*

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Soil and loamy clay	25	....	25	....
Sand and water (flow of 400 gallons per minute)	30	....	55	....
Clay, blue	4	....	59	....
Soil and drift wood	2	....	61	....
Sand, green	4	....	65	....
Sand, gray	6	....	71	....
Clay, hard blue	9	....	80	....
Sand and gravel (five strata)	37	....	117	....
Hardpan	23	....	140	....

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[1] Geological Survey of Illinois, Vol. VIII, pp. 48-49.

Log of air shaft at Decatur—Continued

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Pennsylvanian system—				
McLeansboro—				
Sandstone	1	6	141	6
Shale, soft	6	....	147	6
Shale, gray and blue, sandy	28	....	175	6
Clay shale	15	....	190	6
"Slate," blue	17	....	207	6
Fire clay, ferruginous	6	....	213	6
Limestone, conglomerate	7	....	220	6
"Slate," brown	10	....	230	6
Flint stone	2	6	233	....
"Slate," black	1	....	234	....
Flint rock	2	6	236	6
Coal (No. 11)	....	10	237	4
Fire clay	8	....	245	4
Shale, blue sandy	10	....	255	4
Flint stone	3	....	258	4
Clay shale	5	....	263	4
Shale, sandy	21	....	284	4
"Slate," black	2	6	286	10
Coal (No. 10)	1	....	287	10
Fire clay	6	....	293	10
Shale, black, and 1 inch of coal	8	1	301	11
Fire clay	6	....	307	11
Shale, black	3	....	310	11
Limestone, impure	1	....	311	11
Shale, brown	8	....	319	11
Sandstone	1	....	320	11
"Slate," black	4	....	324	11
Flint stone	11	....	335	11
"Slate," black	12	....	347	11
Fire clay	4	....	351	11
Limestone (Shoal Creek)	10	....	361	11
"Slate," black (No. 9 coal)	2	....	363	11
Fire clay	8	....	371	11
Clay shale	13	....	384	11
Sandstone	5	....	389	11
Flint stone	2	....	391	11
"Slate," blue	8	....	399	11
Clay shale	39	....	438	11
Sandstone, blue	1	....	439	11
"Slate," black	3	....	442	11
Coal (No. 8)	1	4	444	3
Fire clay	6	....	450	3
Shale, sandy	10	....	460	3
Shale, black	33	....	493	3
"Slate," hard black	5	....	498	3

Log of air shaft at Decatur—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Coal (local)	....	3	498	6
Fire clay	4	....	502	6
Limestone	11	....	513	6
Shale, black	4	....	517	6
Clay shale	2	....	519	6
Coal (No. 7)	....	4	519	10
Fire clay	2	....	521	10
Stone, conglomerate	3	....	524	10
Clay shale, gray and blue	14	....	538	10
"Slate," black and ½ inch of coal	4	....	542	10
Fire clay	4	....	546	10
Sandstone	7	....	553	10
Shale, gray	6	....	559	10
"Slate," black	2	....	561	10
Carbondale—				
Coal	1	4	563	2
Clay shale (No. 6)	....	6	563	8
Coal	2	10	566	6
Shale, hard gray	8	....	574	6
Limestone	2	6	577	....
Shale bituminous and coal	....	6	577	6
Fire clay	4	....	581	6
Sandstone	17	....	598	6
Clay shale	3	....	601	6
Sandstone	13	....	614	6
Clay shale, dark	8	....	622	6
"Slate," black	1	6	624	....
Coal (No. 5)	4	6	628	6

Log of well on farm of T. C. Grady, T. 18 N., R. 2 E., Maroa, Illinois.
Elevation—720 feet

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Clay	62	....	62	....
Gravel, hardpan	6	....	68	....
Clay	16	....	84	....
Hardpan	129	....	213	....
Hardpan, sandy	6	....	219	....
Clay, hardpan	54	....	273	....

Log of well on farm of T. C. Grady—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Pennsylvanian system—				
McLeansboro—				
Limestone	15	....	288	....
Shale, light	1	....	289	....
Shale, black	2	....	291	..
Shale, gray	5	....	296	....
Limestone	4	....	300	....
Shale, light	12	....	312	....
Sand shale	30	....	342	....
Shale, gray	28	....	370	....
Limestone	10	....	380	....
Shale, gray	19	....	399	....
Shale, sandy	90	....	489	....
"Slate," dark	10	....	499	....
Carbondale—				
Coal (No. 6)	....	6	499	6
Fire clay	1	6	501	....
Sandstone, gray	3	....	504	....
Shale, light	8	....	512	....
Limestone	9	....	521	....
Shale, blue	4	....	525	....
Limestone	7	....	532	....
Sand shale	34	....	566	....
"Slate," black	3	6	569	6
Coal (No. 5)	1	6	571	....
"Slate," dark	4	....	575	....
Limestone	17	....	592	....
Sand shale	20	....	612	....
Slate, black	4	....	616	....
Shale, light	6	....	622	....
Limestone	4	....	626	....

Log of Niantic Carbon Coal Company's shaft, sec. 12, T. 16 N., R. 1 W.[1]

Elevation—585 feet

Description of Strata	Thickness		Depth	
Quaternary system—	*Ft.*	*in.*	*Ft.*	*in.*
Pleistocene and Recent—				
Soil and clay, brown	11	....	11	....
Sand and gravel	4	....	15	....
Hardpan, gravelly	25	....	40	....
Hardpan, blue	10	....	50	....
Clay, soft	15	....	65	....
Hardpan, gray	10	....	75	....
Clay, soft brown	7	....	82	....

[1] Geological Survey of Illinois, Vol. VII, p. 19.

Log of Niantic Carbon Coal Company's shaft—Concluded

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Pennsylvanian system—				
McLeansboro—				
Limestone	10	....	92	....
Rock, blue flinty	2	....	94	....
"Slate," black	3	....	97	....
Fire-clay	6	....	103	....
Limestone	10	....	113	....
Shale, blue and gray	7	....	120	....
Shale, black	1	....	121	....
Coal (No. 9)	....	2	121	2
Fire-clay	1	....	122	2
Limestone, nodular	5	....	127	2
Clay shale	5	....	132	2
Sandstone, soft blue	16	....	148	2
Shale, gray	42	....	190	2
Coal (No. 8)	1	3	191	5
Fire-clay	2	6	193	11
Sandstone	10	....	203	11
Shale, gray	45	....	248	11
Rock, hard flinty	10	....	258	11
Shale, black	3	....	261	11
Fire-clay	9	....	270	11
Shale, blue and red	15	....	285	11
"Slate," black	5	....	290	11
Coal (No. 7)	1	3	292	2
Fire-clay	4	6	296	8
Shale, black	11	....	307	8
Carbondale—				
Coal (No. 6)	2	6	310	2
Clay shale	15	....	325	2
Shale, black	3	....	328	2
Coal (local)	....	10	329	....
Fire-clay	2	....	331	....
Shale, gray	14	....	345	....
Rock, hard, black (limestone)	1	....	346	....
"Slate," black	3	....	349	....
Coal (No. 5)	5	6	354	6

KNOWN MINABLE COALS IN MACON COUNTY

NO. 5 COAL

So far as is known, No. 5 coal is present in workable thickness below the entire area of Macon County. There has been no prospecting so far as known in the eastern part of the county and future drilling may call for a reversal of the opinion expressed about the continuity of the coal.

MINE NOTES

The best information concerning No. 5 coal is that found in mine notes taken in the various mines of the county as summarized below.

MINE OF THE NIANTIC CARBON COAL COMPANY, AT NIANTIC

Entrance by shaft; 360 feet to No. 5 coal. Working No. 5 coal, which has an average thickness of 5½ feet, varying between 5 and 6 feet. The coal contains small sulphur streaks in the upper part of the bed, but these are not persistent. The clay veins or "horsebacks," characteristic of the bed, are present. A sketch of one made near the face of the main west entry in 1912 is shown in figure 10. In this instance the filling is described as being of two kinds of rock, hard and soft. The former seems calcareous and contains pyrite. The soft part is clay. The clay veins are numerous and greatly increase mining costs.

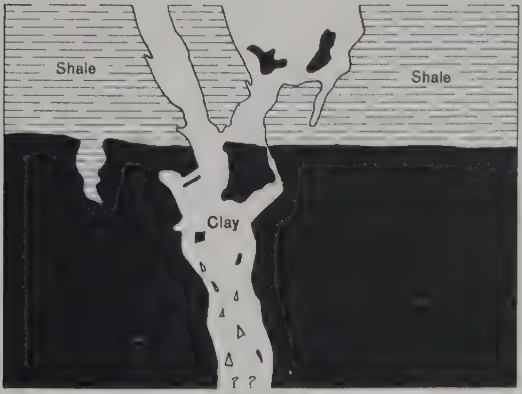

FIG. 10. Sketch of a clay vein ("horseback") in the Niantic Carbon Coal Company's mine at Niantic.

The roof of the coal is commonly black shale or "slate," but varies locally from blue to gray and has a thickness of about 3 feet. Niggerheads are common in this roof. A cap-rock 4 to 12 inches thick is present above the shale.

Sections of the coal in this mine are given herewith.

Sections of No. 5 coal in Niantic mine

Section 1—3d west entry off south entry on the east side	Thickness *Ft.*	*in.*
Roof: Shale, black	..	..
Coal, fairly clean and bright	3	..
Sulphur parting	..	..
Coal, clean and bright	..	2½
Sulphur parting	..	..
Coal, fairly clean	..	8½
Mother coal	..	¼
Coal, dirty	..	2¾
Mother coal	..	¼
Coal, dirty	..	2½
Mother coal	..	¼
Coal, fairly clean	..	7
Floor: Fire clay, dark	..	..
	5	2

Section 2—8th east off north on east side	Thickness *Ft.*	*in.*
Roof: Shale, black	..	..
Coal, fairly clean, bright	2	6
Sulphur	..	⅛
Coal, streaked with mother coal	2	8
Floor: Fire clay, dark	..	..
	2	2⅛

Section 3—1st west off northwest entry, room 35	Thickness *Ft.*	*in.*
Roof: Shale, black	..	..
Coal, top, local only	..	3¾
Coal, clean, bright, slightly streaked	1	8½
Sulphur parting	..	⅛
Coal, streaked with bone	..	4¼
Sulphur parting	..	..
Coal, fairly clean but with some bone	2	8¾
	5	1⅜

MINE OF THE MACON COUNTY COAL COMPANY, AT DECATUR[1]

Entrance by shaft, 560 feet to the floor of mine. No. 5 coal here has a thickness of 4½ feet and 5 feet 1 inch, respectively, where measured in two places. The coal contains some sulphur in bands or lenses, but this impurity is not in large amount. There are some horsebacks. The roof is black, fine-grained shale or "slate" containing niggerheads, which in places in the mine are numerous and of a large size. One was noted which cut out the coal to within one foot of the floor. Above the "slate" is the cap-rock, a hard limestone 10 to 24 inches thick. This is followed by gray shale, 4 to 5 inches thick, overlying which is sandstone.

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[1] Formerly Manufacturers and Consumers Coal Company.

The following sections of coal in this mine are available.

Sections of No 5 coal in the mine of the Macon County Coal Company

Section 1—At face, 3d left entry off the 1st east off 1st south

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean, hard, bright, blocky	3	7
Coal, bony, with little sulphur	..	1
Coal, clean, bright	..	4½
Mother coal	..	½
Coal, fairly clean	..	7
Floor: Fire clay	..	..
	4	8

Section 2—Face of the 9th west off 1st south

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean, bright, hard	2	4
Bone and coal	..	1½
Coal, fairly clean and hard	..	8¼
Pyrite	..	¼
Coal, fairly clean	..	7
Mother coal, soft	..	½
Coal, dirty	..	10½
	4	8

NO. 6 COAL

MINE NOTES

No. 6 coal has been mined at only one mine in this county. Conditions in the mine are shown in the following notes.

ABANDONED MINE OF THE BLUE MOUND COAL COMPANY, AT BLUE MOUND

Entrance by shaft, 472 feet to floor. The coal averages 5 feet, varying between 3½ feet and 6½ feet.

A section measured in the mine is as follows:

Section of No. 6 coal at Blue Mound, face of 1st entry off main west

	Thickness	
	Ft.	*in.*
Coal	2	6
Sulphur	..	½
Coal	..	5
Sulphur	..	½
Coal	1	6
Sulphur	..	½
Coal	..	7½
Blue band	..	1
Coal	..	9
Floor: Fire clay	..	..
	6	0

The roof in this mine is shale or limestone. The shale varies up to 3½ feet and the limestone is known to be as thick as 17 feet.

MASON COUNTY

INTRODUCTION

Coal has never been mined in Mason County and so far as is known, only one drill hole, the one located at Mason City, has penetrated the Pennsylvanian rocks.

SURFICIAL DEPOSITS

The coal-bearing rocks are deeply covered by glacial drift which in the hole at Mason City has a thickness of 204 feet. Its thickness in other places in the county is not known. Leverett says: "The county occupies a low basin-like expansion of the Illinois valley, heavily covered with sand, except where the old river channels have left a surface deposit of muck."[1]

COAL-BEARING ROCKS

Except for information afforded by the drilling at Mason City, and for a general knowledge of conditions in surrounding counties, nothing is known concerning the coal which possibly underlies Mason County. In the drill hole a coal 34 inches thick was struck at a depth of 290 to 293 feet. This thickness of the coal suggests correlation with No. 2 rather than with one of the higher coals. Further evidence in support of this correlation is that No. 5 coal at Lincoln lies at about the same depth and latitude as the coal at Mason City, whereas by reason of the regional eastward dip, No. 5 coal should be considerably higher at Mason City than at Lincoln; in fact, high enough to bring it above erosion level beneath the drift.

It is probable, therefore, though by no means established, that if Mason City is underlain by coal, it is No. 2 rather than one of the higher beds, except in the eastern part of the county, where locally the drift may be thin and one of the higher coals, possibly No. 5, may be present in small areas.

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[1] Leverett, Frank, The Illinois Glacial Lobe: U. S. Geological Survey, Mon 38, p. 688, 1899.

MENARD COUNTY

Production and Mines

Production in tons, year ending June 30, 1920	145,868
Average annual production, 1916-1920	179,861
Total production, 1881-1920	10,639,327

One shipping mine and eight wagon mines reported production in Menard County during the fiscal year 1920. The total production was a little less than .2 per cent of the State's entire output, and the county ranked thirty-first in order of production. Table 6 gives data concerning the shipping mine.

Coal-bearing Rocks

The southern part of Menard County, including the town of Tallula and others, is included in the area of the Tallula-Springfield quadrangles.[1] The north line of these quadrangles passes within less than one mile of Petersburg. The mining operations of the county accordingly lie mostly within the boundaries of these quadrangles, and the description of the coal-bearing strata on those areas given in the U. S. Geological Survey report, is adequate for the county.

The strata underlying Menard County are a continuation northward of those underlying the west half of Sangamon County. The description of these strata presented in the discussion of the coal-bearing rocks of that county will apply approximately to the strata underlying Menard County.

The rocks immediately underlying the drift are included between No. 5 coal which is thought to outcrop near the west line of the county, and the Lonsdale limestone. Accordingly No. 5 coal probably underlies the entire county, and so far as is known is everywhere of workable thickness. No. 6 and No. 7 coals are present east of their lines of outcrop, which run parallel to that of No. 5, between Tallula and the county line to the west. These coals are thin and of no commercial value. No. 2 coal is probably present but it may be too thin to be profitably worked in competition with No. 5. The interval between these coals and the character of the intervening strata have been discussed in the description of the coal-bearing rocks of Sangamon County. The reader is also referred for further detail concerning the geology of the region to the Tallula-Springfield Folio, cited above.

Only six records of drilling or shafts are available in the county, and none exceeds a depth of 165 feet. The only one of these that has sufficient detail to make it of value to this report is reproduced herewith.

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[1] Shaw, E. W., and Savage, T. E., Tallula-Springfield Folio: U. S. Geological Survey Geologic Folio 188, 1913.

Record of shaft of the Loyd coal mine in the NW. ¼ sec. 23, T. 17 N., R. 7 W.

Record given from memory by H. C. Bradt

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary stystem—				
Pleistocene and Recent—				
Clay, surface	20	....	20	....
Pennsylvanian system—				
McLeansboro—				
Limestone	7	....	27	....
Shale, blue	15	....	42	....
Rock, blue	5	....	47	....
Shale, blue	5	....	52	....
Rock, blue	5	....	57	....
Carbondale—				
Coal (No. 6?)	1	2	58	2
Fire clay	4	....	62	2
Flint rock (limestone)	4	....	66	2
Sandstone	11	....	77	2
Shale, blue and red	15	....	92	2
Cap rock (limestone?)	....	6	92	8
Slate	1	2	93	10
Coal (No. 5)	5	10	99	8

MINE NOTES

Observation has been made in four mines in Menard County.

ABANDONED MINE OF THE MIDDLETOWN COAL CO., AT MIDDLETOWN

Entrance: Shaft; 210 feet to No. 5 coal.

Thickness of the coal: Varies from 5 feet 8 inches to 6 feet 2 inches. The average thickness is 6 feet.

Section of the coal:

Section of No. 5 coal in the mine of the Middletown Coal Company, at Middletown

2d west entry off 3d south main entry, about 1,375 feet from shaft

	Thickness	
	Ft.	*in.*
Roof: Black fissile shale	..	..
Coal	2	1
Pyrite	..	⅛
Coal	1	9½
Pyrite	..	⅛
Coal	1	8
Floor: Fire clay	..	..
	5	6¾

Character of the coal: The top coal in the foregoing section is very black and brittle, and has a bright lustre. The rest is not so bright and is softer. Most of the pyrite is found in the middle portion in irregular lenses. Mother coal is less common in the upper coal than in the lower part of the bed. The bed is cut by the usual horsebacks.

Character of the roof and floor: The roof is black fissile shale 1½ to 6 feet thick, with a limestone cap-rock 4 inches to 3 feet thick. The floor is clay above limestone.

ABANDONED MINE OF THE SOUTH MOUNTAIN COAL CO., AT PETERSBURG

Entrance: Slope, 80 feet to the top of No. 5 coal.

Thickness of the coal: Varies from 5½ to 7 feet, averaging 6 feet.

Section of the coal:

Section of No. 5 coal in the South Mountain Coal Company's mine, at Petersburg

1st entry off the 7th east entry about 2,600 feet from slope

	Thickness	
	Ft.	*in.*
Roof: Shale	..	..
Coal	1	4
Pyrite	..	⅛
Coal	..	11
Mother coal		1
Coal	..	7
Pyrite	..	⅛
Coal	1	6
Pyrite	..	⅛
Coal	1	6½
	5	11⅞

Character of the coal and roof: The coal is reported to be cut by clay veins. The roof is shale, probably black, 1½ to 6 feet thick, with a cap rock of limestone 2½ feet or less in thickness usually present.

UNION FUEL COMPANY'S NO. 4 MINE, AT ATHENS

Entrance: Shaft; 203 feet to the top of No. 5 coal.

Thickness of coal: Varies from 5 to 6 feet; averages 5 feet 8 inches.

Sections of the coal:

Sections of No. 5 coal in the No. 4 mine of the Union Fuel Company, at Athens

Section 1—Room 1 off 11th north off main west entry, 6,500 feet from shaft

	Thickness	
	Ft.	*in.*
Roof: Black "slate"	..	..
Coal, bright	2	7
Pyrite	..	¼
Coal, bright	3	3
Floor: Fire clay	..	..
	5	10

Section 2—19th south off main west; entry face, 5,800 feet from shaft

	Thickness	
	Ft.	*in.*
Roof: Black "slate"	..	..
Coal, bright	..	4
Mother coal	..	½
Coal, bright	..	6
Mother coal	..	¼
Coal, bright	4	11
Floor: Fire clay	..	..
	5	9¾

Section 3—Entry face on the main east stub; 1,500 feet from shaft

	Thickness	
	Ft.	*in.*
Coal, bright	3	8
Pyrite streak	..	¼
Coal, bright	1	5
	5	1¼

Character of the coal: The coal lies in a single bed without partings. The middle of the bed contains a few pyrite lenses running parallel to the bedding, and the bottom 4 inches of the coal is bony in many places. There are no persistent impurities, however. "Horsebacks" occur with the usual frequency. The accompanying figures 11 and 12 are reproduced from sketches made of two kinds of clay veins, in one of which the fracture is about vertical and there has been no offset of the bed, and in the other an inclined fracture is accompanied by offset. Figure 11 shows also how the clay in the floor bulges up toward the "horseback" but does not enter it, the vein material being apparently entirely different from the underclay. In figure 12 it will be noted that the fracture does not extend up into the cap rock.

The coal is broken also by what seems to be true faults which cross all the strata associated with the coal. In this case the limestone rests upon the coal; the difference in the character of the fractures may be due to this fact.

The clay veins vary in width, but their maximum is about 2 feet. The filling consists of clay with small fragments of coal scattered through it. These fragments are sharp, unshattered, and have the same appearance as the coal in the bed. In one case where the floor has apparently been pushed up about 18 inches, no displacement was noted in the roof of the coal, although the fracture extended into the cap-rock, with a width of 1 to 1½ feet across, slightly less than its width in the coal.

Character of the roof: The immediate roof is usually black "slate," which varies from 6 inches to 6 feet in thickness, but averages 2 feet. In places it is less hard and sheety and becomes less like a "slate." This more massive shale is most everywhere wet and eventually falls to the cap rock. The cap rock is usually strong enough to stand where these falls occur.

The cap rock is a very carbonaceous limestone about 5 feet in thickness. Ordinarily it forms a good roof. In a few places the limestone is in contact with the coal. This contact, however, is not sharp on account of the common occurrence of coal stringers in the lower 2 inches of the rock.

The cap rock locally also cuts down through the "slate" as a "roll" under which the coal is ordinarily somewhat crushed. Overlying the cap rock is a gray "soapstone" or shale. In places the cap rock is represented

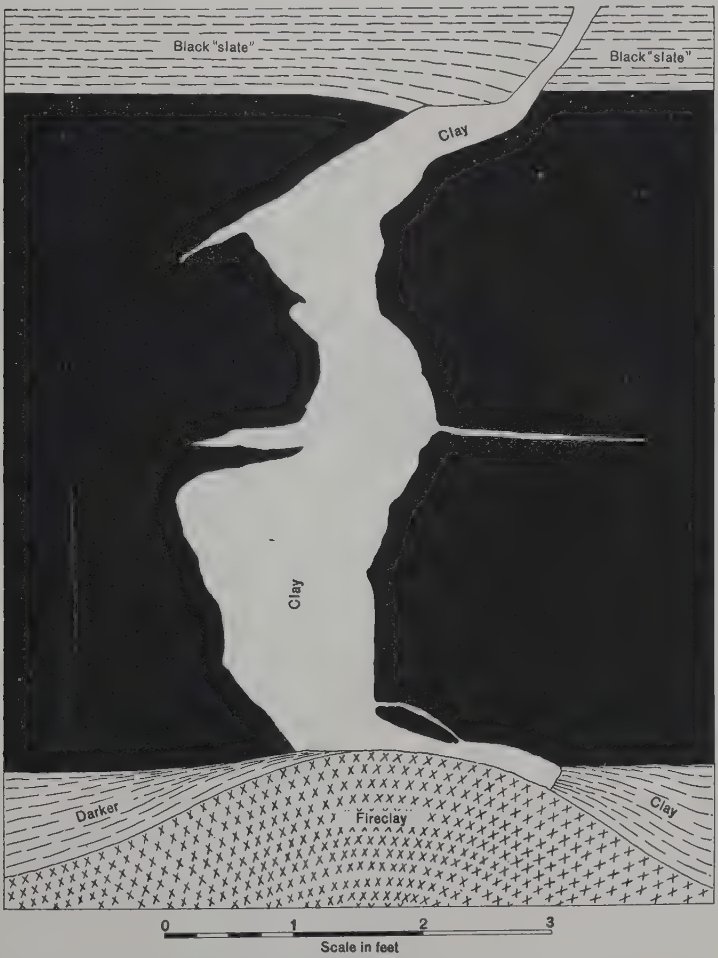

FIG. 11.—Sketch of a nearly vertical clay vein ("horseback") in the Union Fuel Company's No. 4 mine at Athens. The fracture is not accompanied by an offset.

only by a band of boulders, the gray shale resting directly upon the black "slate," except for these nodules.

Character of the floor: The underclay is reported to have a thickness of 14 feet. The upper 7 feet is said to be rather soft and to contain many nodules or "boulders." The upper 18 inches is said to heave somewhat.

ABANDONED MINE OF THE TALLULA COAL COMPANY, AT TALLULA

Entrance: Shaft; 179 feet to No. 5 coal.

Thickness of coal: Varies from 5 feet 8 inches to 7 feet 6 inches; averages 6 feet.

Section of the coal:

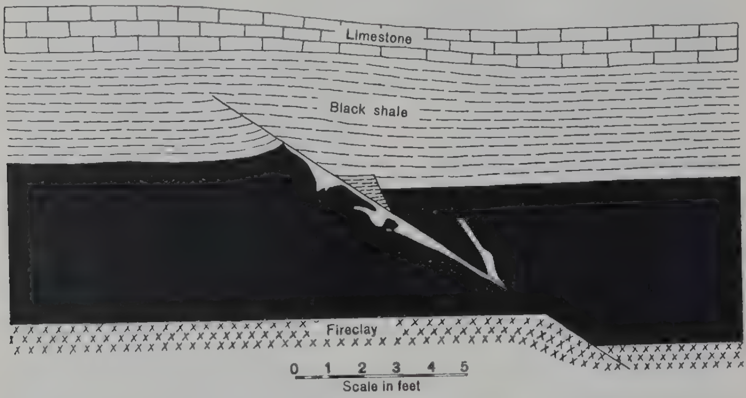

FIG. 12.—Sketch of an inclined clay vein ("horseback") in the Union Fuel Company's No. 4 mine at Athens. The bed is offset.

Section of No. 5 coal, Tallula Coal Company, at Tallula.

	Thickness Ft.	in.
Roof: Black shale	..	..
Coal	1	3
Pyrite	..	⅛
Coal	2	6
Pyrite	..	1
Coal	..	6
Pyrite	..	⅛
Coal	1	8
Floor: Fire clay	..	..
	6	¼

Character of the coal, roof, and floor: The coal bed is crossed by numerous clay veins. It has the usual black "slate" roof 14 inches to 6 feet thick, with a limestone cap rock 3 inches to 3 feet thick.

PEORIA COUNTY

Production in tons, year ending June 30, 1920	1,244,013
Average annual production 1916 to 1920	1,327,926
Total production 1881 to 1920	31,867,000

Peoria County ranked 14 in production in 1920; the output in that fiscal year (1919-1920) was 1.7 per cent of the total output of the State. During 1920 there were 2 shipping mines operating in this county and 51 local or wagon mines. The local mines produced 183,689 tons of coal. Most of the mines operated in No. 5 coal, but there was some coal mined from No. 6 coal, and plans have been made to resume operations in No. 2 coal in the Wantling (Blue Fly) mine at Pottstown.

Coal-bearing Rocks

The geology of the portion of this county in which mining operations are most active has been described in detail after careful field examination by Dr. J. A. Udden.[1] Much of the geological information included in the following paragraph is drawn from his publication.

The thickness of the coal-bearing strata is about 520 feet, of which the lower 300 feet is known only from drilling or mine shafts. The exposed 220 feet extends downward 20 feet below the chief productive coal bed. The most reliable and detailed information concerning the lower unexposed portion of the section is based upon the records of two shafts. One of these, located at Pottstown, passes through No. 2 coal at a depth of 106 feet, has a depth of 240 feet, and reaches a bed believed to be equivalent to the Ellisville or Rock Island coal. The workings in No. 2 coal in this mine have been reopened. The other shaft, at Orchard about 4 miles south of Bartonville, extended down to a coal bed believed to be No. 2, and equivalent to the upper bed in the Pottstown shaft. The section of strata in these two shafts follows:

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[1] Udden, J. A., Geology and mineral resources of the Peoria quadrangle, Illinois: U.S. Geological Survey Bull, 506, 1912.

Section of rocks penetrated by the shaft of the Blue Fly mine at Pottstown, west side of the SW. ¼ sec. 36, Kickapoo Township, Peoria County[1]

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Alluvium	10	----	10	----
Sand, dry	6	----	16	----
Gravel	3	----	19	----
Hardpan	2	----	21	----
Pennsylvanian system—				
Carbondale formation—				
Soapstone, white	10	----	31	----
Iron band	----	2	31	2
Soapstone	8	----	39	2
Iron band	----	3	39	5
Shale, black	20	----	59	5
Iron band	----	3	59	8
Soapstone, white	20	----	79	8
Iron band	----	2	79	10
Shale, white	4	----	83	10
Iron band	----	4	84	2
Shale, white	3	----	87	2
Iron band	----	2	87	4
Shale, dark	6	----	93	4
Cap rock	2	----	95	4
Slate, black	2	8	98	----
Shale, white	9	----	107	----
Coal (No. 2)	2	8	109	8
Pottsville formation—				
Fire clay	4	----	113	8
Sandstone	17	----	130	8
Soapstone	6	----	136	8
Sandstone, white	56	6	193	2
Clod, black	3	6	196	8
Fire clay	1	6	198	2
Coal	2	4	200	6
Sandstone, dark	4	6	205	----
Rock, hard	3	6	208	6
Clod, dark	8	----	216	6
Sandstone, hard	7	6	224	----
Slate, black	3	----	227	----
Shale	2	----	229	----
Rock, white	3	----	232	----
Coal	1	4	233	4
Clod, black } No. 1	3	6	236	10
Coal	3	----	239	10
Fire clay	1	----	240	10

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[1] Op. cit., p. 23.

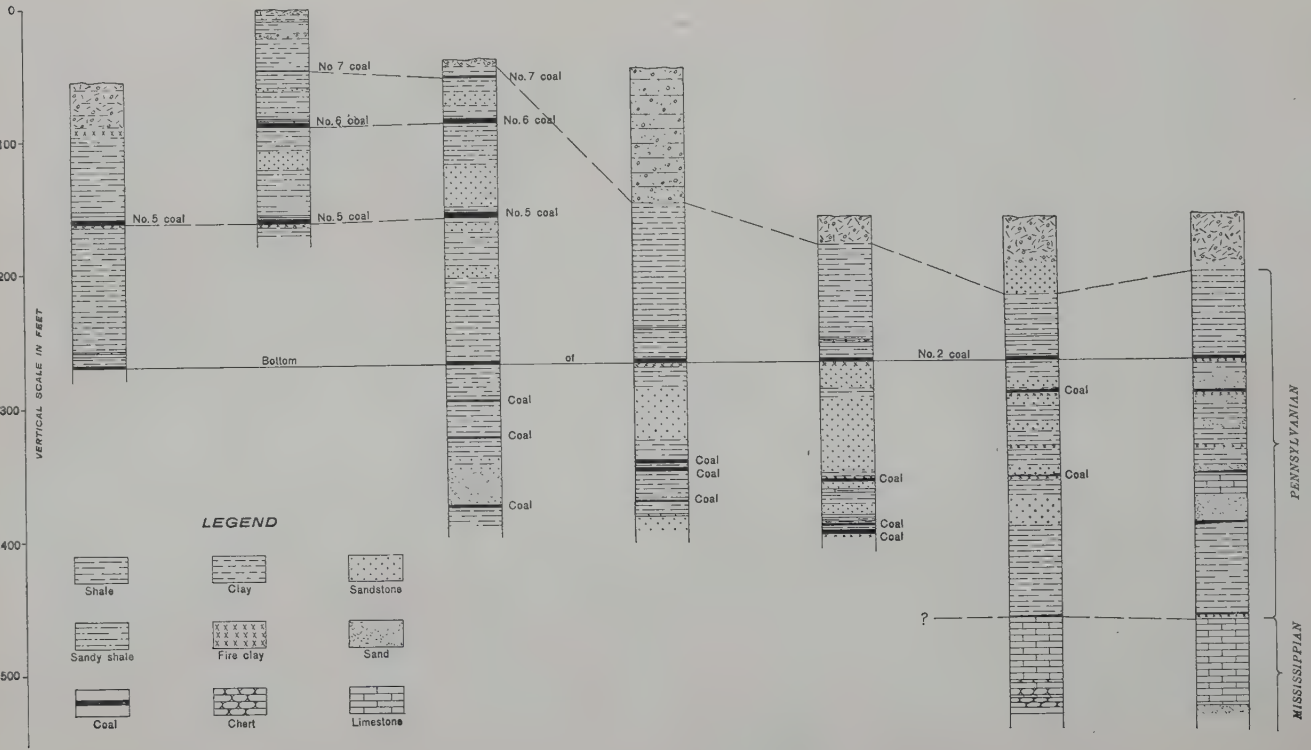

FIG. 13.—Graphic sections showing the character of the Pottsville formation in Peoria County.

Section of the Orchard shaft[1], *about 4 miles south of Bartonville*

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system—				
Pleistocene and Recent—				
Surface	3	....	3	....
"Fire clay"	2	....	5	...
Hardpan	1	8	6	8
Loam, black	3	6	10	2
Pennsylvanian system—				
Carbondale—				
Shale, black	....	9	10	11
Soapstone, soft	2	....	12	11
Shale, sandy	7	6	20	5
Limestone	2	....	22	5
Sandstone	17	....	39	5
Soapstone	4	....	43	5
Iron band	....	8	44	1
Soapstone	18	....	62	1
Sandstone, blue	4	....	66	1
Soapstone	36	....	102	1
Slate, gray, and iron band mixed	16	....	118	1
Slate, black	4	8	122	9
Hardpan	1	8	124	5
Slate, black	....	10	125	3
Soapstone	12	....	137	3
Coal (No. 2)	2	6	139	9
Pottsville—				
Fire clay	1	10	141	7

POTTSVILLE FORMATION

The succession of the Pottsville formation in Peoria County is not very definitely known. Several of the better records are reproduced graphically in the accompanying figure (Fig. 13).

Study of the available drill records, several of which are included in figure 13, indicates that the base of the Pennsylvanian system is commonly at an elevation of about 140 feet above sea level in the vicinity of Peoria. Although this figure is a generalization, it is thought to be accurate within about 25 feet. In the northwest part of the county near Princeville, the base of the "Coal Measures" is probably more than 300 feet above sea level, and along the Fulton County line near Farmington, between 270 and 300 feet. The pre-

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[1] Op. cit., p. 24.

Pennsylvanian surface accordingly probably slopes about 10 feet to the mile. There is some evidence that the surface of the Mississippian strata upon which the "Coal Measures" rest is uneven, aside from the general slope just mentioned, and therefore the Mississippian may be reached at depths which vary somewhat from what would be expected. However, if the character of the drilling chips is carefully noted when wells or tests are being put down, there should ordinarily be no difficulty in determining the base of the "Coal Measures," as at that horizon the drill passes from a succession of shales, sandy shales, and sandstones into massive limestone.

The strata in the lower 100 feet of the Pottsville are apparently mostly shale, with interbedded sandstone reported in two wells. Drill cuttings from the Glen Oak Park well, taken about 20 feet above the base of the "Coal Measures," contained coal, according to Udden.[1] Coal was reported in the Carter well in East Peoria at about the same level but was either not recorded or not present in other wells in the region. In the interval from about 100 feet above the base of the formation (at an altitude of 220 to 240 feet) up to No. 2 coal (at various altitudes between 330 and 380 feet) there seem to be several coal beds. The meager information at hand is sufficient for correlation of the coals found in the different holes. It is not even safe to assume that the coal found in several holes at an altitude of 220 to 240 feet is a continuous bed, as Pottsville coals in Illinois are characteristically lenticular, having been deposited in what apparently were local basins that probably did not synchronize.

Coal at an altitude of 226 feet and at a depth of 236 feet has been mined at Pottstown. The coal in this mine lies in two benches, the lower one according to Udden,[2] varying from 2 feet 2 inches to 3 feet, and the upper measuring 1 foot 3 inches. The two benches are separated by nearly 3 feet of shale, and the average thickness of the coal and included shale is 6 feet. Udden states that this coal bed has been recognized in no less than six of the artesian borings in the vicinity of Peoria and Pekin, but as was stated in the previous paragraph, the correlation of these lower coals upon the basis of water-well records, in several cases of doubtful accuracy, is not possible; especially is this evident when several diamond-drill holes the records of which have become available since the field work on the Peoria quadrangle was completed, show several thin coals in the section below No. 2 coal. Yet it is not at all improbable that this lower coal may be fairly continuous, at least in the southern part of the county, for it is reported in a drilling at Elmwood at the west edge of the county.

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[1] U. S. Geological Survey Bull. 506, p. 35.
[2] Op. cit., p. 25.

The strata in the upper part of the Pottsville above the lower coal, which Udden[1] suggests is the No. 1 coal, are variable. In the Pottstown shaft they are largely sandstones with a 28-inch coal bed about 40 feet above the No. 1 coal. Two records in Limestone Township report several black shales and thin coals in the succession, as well as a large amount of sandstone and sandy shales. These records both report coal between 1 and 2 feet thick about 30 feet below the top of the formation, or No. 2 coal. The record of the drilling at Elmwood shows almost continuous shale. The interval between coals No. 2 and No. 1 seems to vary from about 100 to 140 feet. It is not probable that any of the intervening coals are of workable thickness.

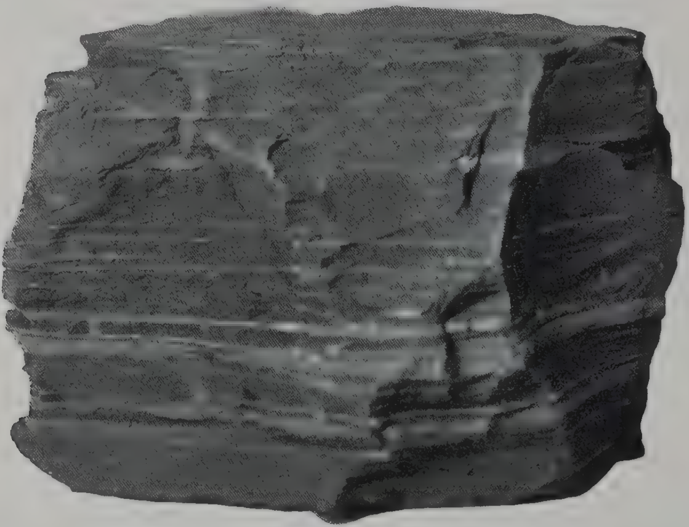

FIG 14.—Photograph of a block of the roof shale of No. 5 coal in Peoria County, showing laminated structure.

CARBONDALE FORMATION

The Carbondale formation includes all the coal beds worked in the county, and is economically the most important part of the "Coal Measures" section, not only in this county but in the State as a whole. With the exception of the small mine at Pottstown which has recently reopened an old development in No. 2 coal the commercial operations in the county are all in No. 5 coal. No. 6 coal has a little development by wagon mines at various places in the county.

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[1] Op. cit., p. 81.

NO. 2 COAL

No. 2 coal lying at the base of the formation has the usual characteristics of that bed in the northern part of the State. It is about 30 inches thick and is overlain by the gray "soapstone" and black fissile shale which is the very characteristic roof of this coal in the typical La Salle region. The coal contains the bright sulphur balls also common to this bed. Besides its similarity in appearance and occurrence as a basis of correlation with No. 2 coal, there is a similarity in the flora in the shale above this coal and in that above the coal at La Salle, which Dr. David White[1] regards as suggestive of correlation.

STRATA BETWEEN NO. 2 AND NO. 5 COALS

The interval between No. 2 and No. 5 coals varies from 110 to 140 feet, and except for the uppermost 25 feet, is known only from records of test holes, wells, and shafts. The section seems to be largely shale with some bands of ironstone or hard limestone probably containing considerable pyrite or iron carbonate, and with layers of sandstone. A few records show streaks of coal interbedded with the shale. The massive sandstone found in the upper part of the series between coals No. 2 and No. 5 in Fulton County does not seem to be generally present at least in eastern Peoria County.

NO. 5 COAL

No. 5 coal is a single bed without partings or bands and varies from about 4 feet to 4 feet 8 inches in thickness. The bed is cut by numerous clay "veins" which also penetrate the strata above the coal for an undetermined distance. When narrow and not filled with clay gouge, the vertical fractures are commonly cemented by a pyritic vein material. The coal contains several varieties of "sulphur" or pyrite, such as sulphur balls, lenses of gray and brown sulphur, sulphur spars or vein filling noted in the preceding sentence, and "blackjack" or pyritized mother coal. Of these forms probably the gray to brown lenses of laminated pyrite which occur in special abundance near the horsebacks constitute the most characteristic variety. The coal displays no physical characteristics in itself that serve to distinguish it from other coals in the State. It has the usual banded appearance of Illinois coals due to interlamination of dull and bright coal.

Distribution of No. 5 coal.—As No. 5 coal lies above the level of the present drainage lines in a considerable part of the county, it is consequently absent within the Illinois valley and for some distance up the larger tributary valleys. Above Kramm, the coal outcrops along the sides of Kickapoo Creek and is mined by drift mines.

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[1] Op. cit., p. 26.

The distribution of the coal is further limited by pre-glacial drainage lines which apparently correspond in general with those of the present, though the earlier valleys are wider and deeper than those now existing. A map of the pre-glacial surface for the whole of the county is not possible with the information now available, but Plate VI reproduced here from Doctor Udden's report[1] shows the pre-glacial surface for the Peoria quadrangle. The following description of the bed-rock surface in the Peoria region is also reprinted from the same report.

> Erosion in pre-glacial time had produced a land surface which differed considerably from the present topography. Since that time the land has been rebuilt by glaciation, the general effect of which has been to reduce the relief. The old land surface has undergone some changes by post-glacial agencies, but these are small. The present surface of bed rock is known mainly from wells and other excavations that have penetrated the drift. These data are not very numerous, but an attempt has been made to present the general features of the rock surface in the quadrangle by contour lines on a separate map (Pl. VI). Where data are wanting, the probable course of these contours is indicated by interrupted lines.
>
> In the area west of Kickapoo Creek and Illinois River, the old rock surface closely parallels that of the land today. In Limestone Township it reaches an elevation of 675 feet in secs. 5 and 6. From here it descends southward to an average height of 550 feet in the uplands of Hollis Township. The two Lamarsh creeks and Kickapoo Creek above Pottstown occupy valleys which were eroded before the deposition of the drift. Below Pottstown the last-named stream evidently has been lately crowded up on the east slope of the old upland to the west, and from Horseshoe Bottom to Bartonville it has cut a new and comparatively narrow valley on this slope.
>
> Under Peoria, and also under the upland for a distance of 3 miles north from the city, and on the east side of the river north of Farm Creek, the rock surface has an average altitude of about 400 feet above sea level. This is 200 feet lower than the same surface in Limestone and Hollis townships. It rises, however, north from Pottstown, so as to bring the "Coal Measures" again into view in some of the creeks immediately north of the north boundary of the quadrangle. South from Farm Creek, on the east side of Illinois River, bed rock rises and reaches its highest altitude of 600 feet above the sea in sec. 7, Groveland Township. Under the upland to the south it gradually sinks to an average height, as far as known, of about 525 feet in the south part of Elm Grove Township. Two wells on the lowland south of Pekin reached altitudes of 430 and 420 feet above sea level without entering bed rock. In and near the present valley

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[1] Op. cit., p. 51.

of the river the surface of bed rock is lower than in other localities, as shown by an altitude of 355 feet above sea level at the Colean factory well, 345 feet near Iowa Junction, and 340 feet in the Pekin waterworks wells.

It is not improbable that beyond the boundary of the Peoria quadrangle similar irregularities in the pre-glacial surface also exist and it is quite possible that in places lines of pre-glacial or inter-glacial drainage might have developed in positions not now occupied by streams. Such is the case in the eastern part of Fulton County and it is not improbable that some of these drainage lines extend into western Peoria County.

A third limitation upon the distribution of this coal is an intraformational sandstone which apparently occupies channels cut through the coal some time after the No. 5 coal was deposited but prior to the deposition of No. 6 coal. In other words it is believed that after the accumulation the peat and overlying muds which later became No. 5 coal and its roof shales, land streams came into existence and cut channels into and in many places through the muds and peat; and that eventually the channels were filled with sand, which later became sandstone. The channel deposits apparently have a fairly definite alignment similar to an ordinary stream channel and probably have the usual branches or tributaries, and gradient. Along such channel lines, the coal is now absent, the bed terminating laterally against a massive sandstone, the sandstone in places presenting a nearly vertical wall, and in other places appearing first in the roof and gradually pinching the coal out toward the bottom.

In parts of Peoria County it has been possible to outline the position of the channel deposits (fig. 22), but for most of the area information on which to base a map is insufficient. As this sandstone is younger than No. 5 coal, further discussion is reserved for the following section on the strata between No. 5 and No. 6 coals.

It may well be emphasized here, however, that in exploring new properties in Peoria County the determination of the position and depth of the lines of pre-glacial drainage and the location of channel sandstones which may cut through the No. 5 coal become matters of great importance. It is not safe to open any property in the county without learning the facts in regard to these two uncertain elements. Carelessness in this regard may result in the operator suddenly finding himself without adequate roof and even without coal.

STRATA BETWEEN NO. 5 AND NO. 6 COALS

Over No. 5 coal is a black fissile shale ("miners' slate") similar to that of Fulton County. In the course of Doctor Udden's more detailed description,[1] he mentions the whitish streaks found in this shale as shown in figure 14, and describes small calcareous nodules and the larger "niggerheads" which characterize this bed. Above the roof shale is a layer of limy shale which merges into the limestone caprock above. When the clay and limestone above is soft, it is generally known as clod and is very fossiliferous.[2] At the top of the clod in many places is a bed of sulphur (marcasite) 2 to 6 inches thick, the lower surface of which is very irregular due to protuberances 1 to 3 inches in height and width, called by the miners, "cat" or "cat claw." Where the marcasite is more calcareous and clayey, it is called the "iron band."

Above the clod is a shale which in most places measure 4 to 8 feet but which reaches a thickness of 20 feet locally, due to its uneven upper surface. This is overlain by a sandstone averaging 55 feet in thickness, the lower surface of which conforms with the irregularities of the uneven surface of the shale, as described above. It is this sandstone that in places continues down through the horizon of No. 5 coal, forming what have been alluded to above as the channel sandstones; and it is described by Udden as the most conspicuous unit in the exposed section of the "Coal Measures" in this region. It is present almost continuously in the west bluffs of Kickapoo Creek from Bartonville to Pottstown and in the bluffs of the same stream south of Edwards. It appears along almost every stream which drains the upland on the west side of Illinois River and Kickapoo Creek and also in some creeks near East Peoria in Tazewell County.

The sandstone just described changes somewhat abruptly into shale and fire clay above.[3] There is generally 3 to 4 feet of dark or gray, slightly sandy shale above the sandstone, which is overlain by 2 to 3 feet of fire clay of greenish-gray color. The fire clay immediately underlies No. 6 coal.

By way of summary, a section of the outcropping strata from No. 5 coal to some distance above No. 6 coal is given below.

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[1] Op. cit., pp 29-30

[2] Op. cit., p. 30

[3] Op. cit, p. 32.

Section of the rocks in the west bluff of Kickapoo Creek, near the Schmidt mine near the south line of sec. 13, Limestone Township

Description of Strata	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Drift	40	----	40	----
Sandstone, thin bedded	10	----	50	----
Shale, black	----	6	50	6
Coal, impure, weathered (No. 6)	----	7	51	1
Coal (No. 6)	1	8	52	9
Clay, red (No. 6)	----	3	53	----
Coal (No. 6)	1	1	54	1
Fire clay	1	6	55	7
Sandstone, thin bedded and fine-grained, almost shaly	19	----	74	7
Sandstone, moderately coarse, homogeneous	2	----	76	7
Sandstone, thin bedded, soft, fine grained, with thin clay seams	13	----	89	7
Sandstone, thick bedded	23	----	112	7
Shale (near mine)	9	----	121	7
Shale ("slate")	1	----	122	7
Coal (No. 5)	4	4	126	11

Discussion of the channel sandstones.—The correct interpretation of the sandstone "faults" in No. 5 coal in Peoria County is a matter of some moment to the operators in the southern part of the area, because the accepted interpretation will have considerable control over the exploration methods. They are believed by the author to be channel sandstones, but the older alternative view of Doctor Udden, presented in his report on the Peoria quadrangle and outlined below, must be taken into consideration.

The manner in which the sandstone cuts out the coal has been described very briefly in the preceding section of No. 5 coal, and additional facts about the phenomenon are to be gathered from the accompanying illustrations (figs. 15-20) and the following notes on variations in coal thickness on fractures adjacent to the "faults":

In two of the mines along the east side of the channel sandstone or "fault" in Hollis Township (T. 7 N., R. 7 E.), the coal shows unusual variations in thickness, the bed increasing rather than diminishing in thickness, as compared with the average thickness. Sketches and figures from the mine of the Leitner (formerly German) Coal Company, indicating that in places in this mine the coal thickens to 10 feet, apparently due to duplication or overthrusting of the bed produced by lateral pressure. A similar thickening of the coal has been observed in Brewster and Evans

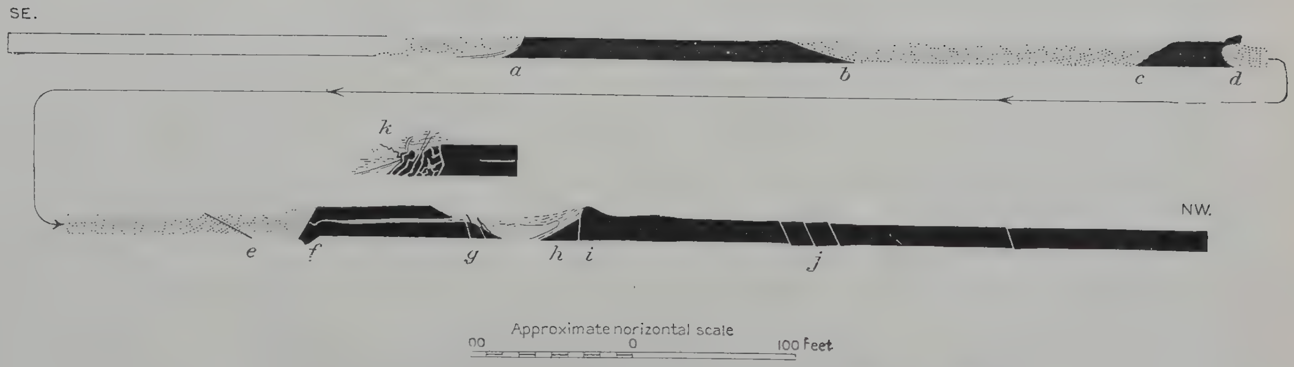

FIG. 15.—Sections of the main entry of the Leitner (formerly German) Coal Company's mine, showing the relations of the channel sandstone to the coal. See Fig. 16 for photograph at *d;* Fig. 17, at *f;* Fig. 18, at *g;* Fig. 19, at *k*, opposite *g;* and Fig. 20, opposite *h.*

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(Walben) mine in the short distance north of the Leitner mine. In the Walben mine no evidence of overthrusting was observed but the coal increased in thickness gradually from a general average of 4 feet 6 inches to 5 feet 6 inches at the edge of the "fault."

In these same mines evidence of disturbance is also seen in the folding, fracturing and shattering which affects the coal, as illustrated in figures 15 to 20. In some instances the coal is so brecciated and broken that it may be easily worked with pick and shovel.

After describing in accurate details the fractures, disturbances,

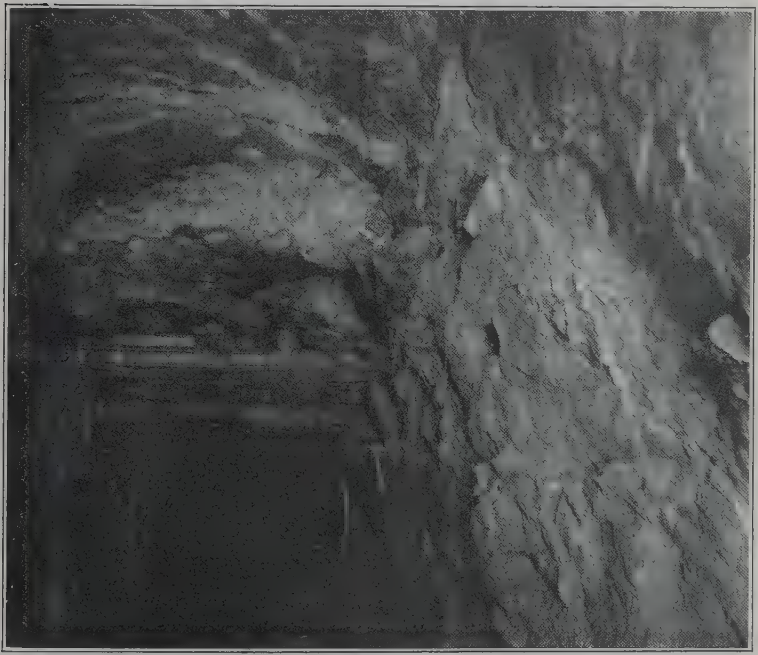

FIG. 16.—Photograph of the roof and southwest wall of main entry of the Leitner Coal Company's mine in the SE. ¼ sec. 2, T. 7 N., R. 7 E.

Looking southeast. (See fig. 15, *d.*) A projecting flange of the coal is seen in the center rising in the roof over the timbers. Several of the shearing joints show indistinct horizontal striae or flutings.

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and thickening of the coal at the contact of the coal and the channel sandstone, as summarized above, Udden[1] assigns the phenomena to glacial fracturing:

> "The author believes that the fractures are disturbances in the upper part of the soft bed rock, caused by the pressure and motion of a continental ice sheet in Pleistocene time; that they are planes marking the outlines of immense blocks of the uppermost rock strata, tens, or possibly hundreds of acres in extent, which have been dislodged from their original position, displaced, fractured, rotated horizontally and in places vertically, and partly ground into the till. He regards the region as having been a locus of incipient glacial abrasion. Instead of thoroughly triturating the grist, the glacial mill here merely blocked it out of the old land on which it spent its force."

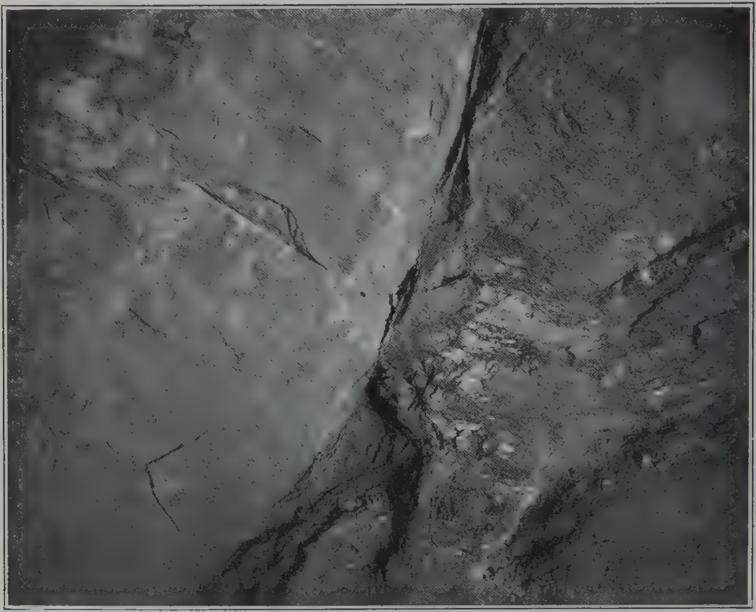

FIG. 17.—Photograph of the left (southwest) wall of the mine entry shown in Figure 16.

Looking southwest. (See fig. 15, *f*.) A fracture runs diagonally across the center of the field separating the sandstone on the left from the coal on the right. Near the sandstone the coal is shattered and mixed with fragments of shale and sandstone.

Reproduced from Bull. 506, by permission of the U. S. Geological Survey.

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[1] Udden, J. A., Geology and mineral resources of the Peoria quadrangle: U. S. Geological Survey Bull. 506, p. 77, 1912.

In support of Udden's theory, it is true that along the lines of the pre-glacial valleys, especially where cut into deeply by the present streams, there is abundant evidence of local dislocation by what may be called ice push. And it is also true that such localities in some instances happen to be in areas corresponding to or contiguous to the area occupied by the channel sandstone in the Lamarsh Creek basin. However, in the author's opinion, to assign the absence of the coal and other phenomena observed at the sandstone "faults," to glacial dislocation seems to call for an unusual and almost improbable exhibition of glacial activity.

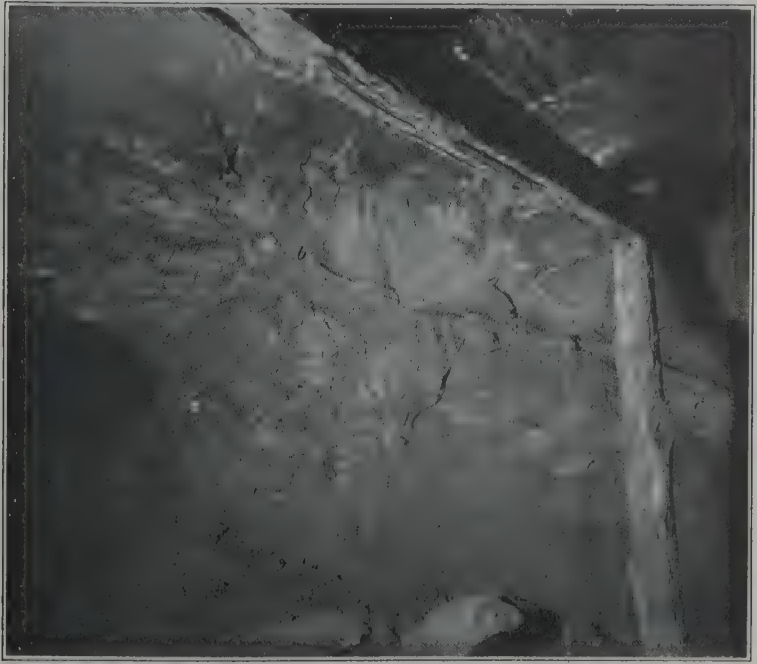

FIG. 18.—Another view of the mine wall shown in Figure 17. (See fig. 15, *g*.) An S-shaped sheared fracture is indicated by the letters *a*, *b*, *c*. Somewhat irregular indistinct horizontal flutings appear to the right of a line joining *a* and *b*.

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The author's interpretation of the sandstone "faults" is indicated by the use of the term "channel sandstone" and is outlined here in historical form:

After the accumulation of the peat and overlying muds now represented by No. 5 coal and its roof shales, land streams came into existence and cut channels into the muds and peat, thereby removing both mud and peat along their courses (fig. 21A). Eventually a layer of sand at least a score of feet thick and in many places much thicker

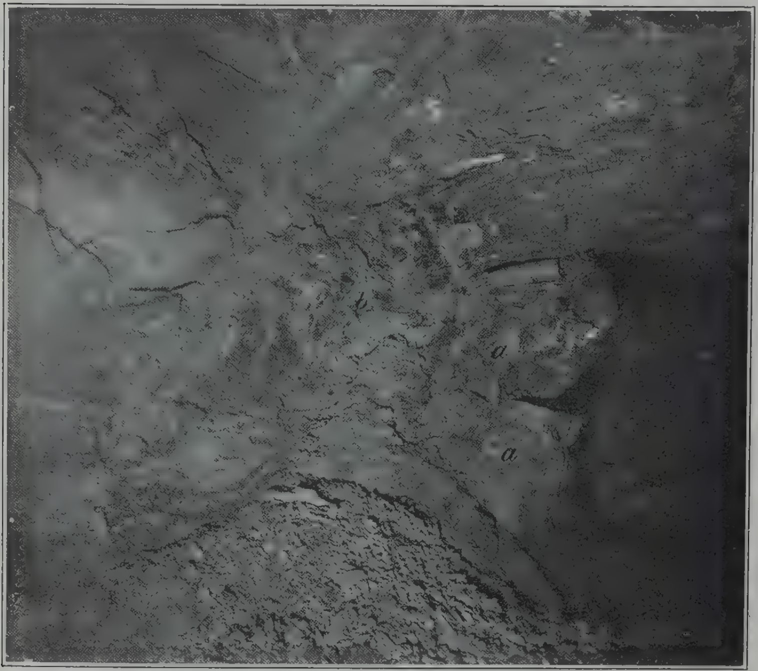

FIG. 19.—View of the right (northeast) wall of the same mine entry as Shown in figures 15, 16, 17, and 18.

Looking northeast. (See fig. 15, *k*, opposite *g*.) The fractured face of the coal appears above and to the left of the receding entry in the lower right-hand corner of the view. Horizontal flutings appear on the face of the coal at *a*. An S-shaped belt of fissured coal and shale separates the coal from the sandstone on the left, and other fissures, roughly parallel to this belt, appear indistinctly at *b*.

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was spread widely over the region, thickest of course along the positions of the channels and thinner over the intervening areas (fig. 21B). Subsequently the sand was covered over by the muds and silts upon which the peat for No. 6 coal was still later deposited. With the burial of the peat and overlying muds and sands under an increasing load of still younger sediments, the peat changed gradually into coal and the muds and sands into shales and sandstones. In such a process of consolidation, the muds and shales shrink comparatively little, but the peat is reduced to some such fraction as one-fifth of its original thickness. The consequent differential shrinkage between the strata away from the channel lines resulted in the setting up of pressures and strains which were relieved in such a way that the fracturing, coal

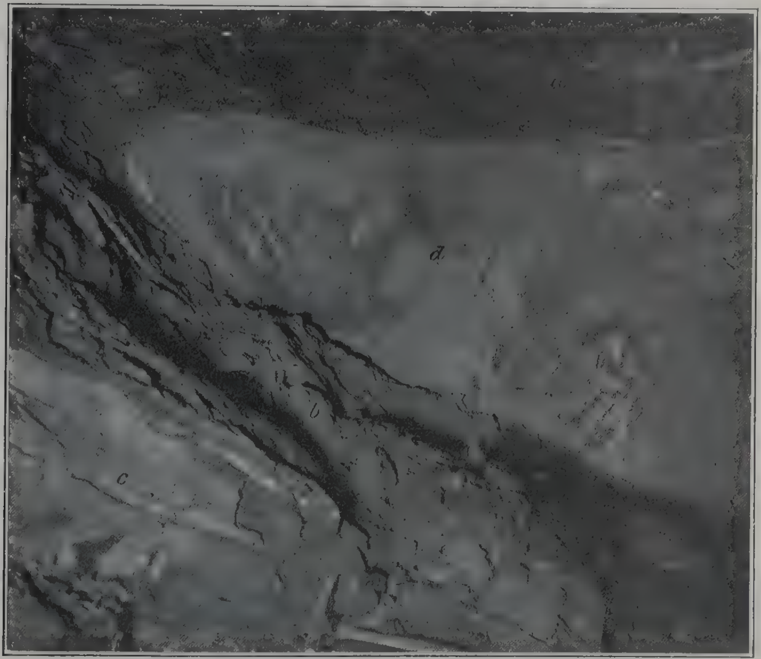

Fig. 20.—Another view of the mine wall shown in Figure 16. (See fig. 15, opposite *h*.) Bed *a* is dark shale with some streaks of coal, somewhat shattered, possibly the same as *b*; *b* is the roof shale of No. 5 coal; *c* is No. 5 coal; *d* is sandstone.

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thickening, and attendant phenomena exhibited at the "faults," were developed. Figure 21C is an attempt to present diagrammatically the author's idea of the way in which the forces probably acted in effecting the readjustments made necessary by the differential shrinkage.

The economic bearing of the correct interpretation of the phenomena rests upon the importance of determining the nature of the

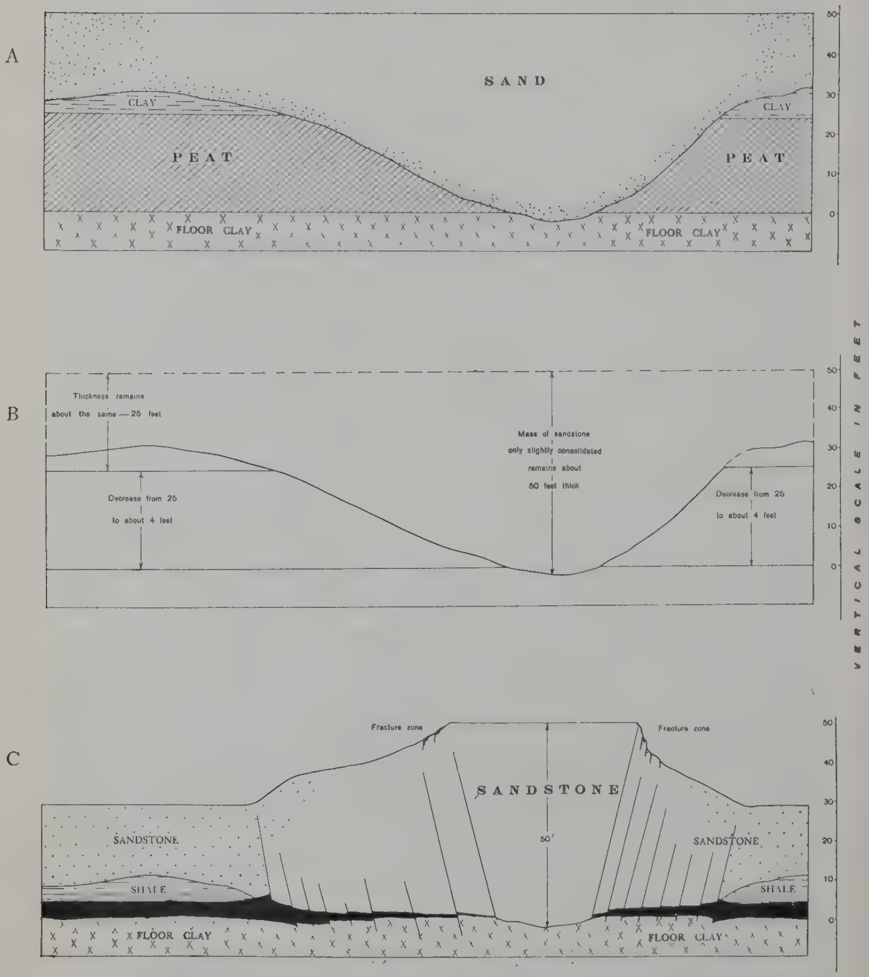
A
SAND
CLAY
CLAY
PEAT
PEAT
FLOOR CLAY
FLOOR CLAY
50
40
30
20
10
0
B
Thickness remains about the same — 25 feet
Decrease from 25 to about 4 feet
Mass of sandstone only slightly consolidated remains about 50 feet thick
Decrease from 25 to about 4 feet
VERTICAL SCALE IN FEET
C
Fracture zone
Fracture zone
SANDSTONE
SANDSTONE
SANDSTONE
50'
SHALE
SHALE
FLOOR CLAY
FLOOR CLAY

FIG. 21—Diagrammatic sketch, indicating probable original conditions, movements, and results, in the formation of the channel sandstones ("faults") of Peoria County. See text for explanation.

"fault." If this is a purely glacial phenomenon related to ice shove, as proposed by Udden, then the delineation of areas where such a phenomenon is to be found becomes very difficult. But if on the other hand the disturbance can be traced to the existence of a channel sandstone, it becomes a matter of reasonable possibility to locate the position and trend of such a deposit. Without examining the "channel sandstone" interpretation at length, two points may well be mentioned here in its support, the first very briefly, but the second in somewhat more detail and with a map because of its weight and its practical application to the "fault" problem.

1. The pressures and strains developed by differential settling of the magnitude assumed, would seem to be entirely adequate to the production of the features now observed at the "faults."

2. As a result of the past ten years' investigation, drilling, and mine operations, engineers and operators have analyzed the "faults" as masses of sandstone penetrating below the horizon of the coal and have blocked out their extent over an area sufficient to indicate that they have the general alignment of stream channels.

The position of the channel sandstones over the whole of the Peoria region is not very definitely known. Many of the mines south of Peoria and those in Tazewell County near East Peoria have felt out the edge of the "faults" so that some idea of the position of one of the sandstones is available. South of Peoria the Leitner Coal Company's mine, and the Walben mine, M. E. Case Coal Company have worked up to the edge of the sandstone. The Wolschlag mine is reported to lie immediately to the east of the "fault." Numerous drill holes to test the coal have penetrated the sandstone in the area lying between the east branch of Lamarsh Creek and the Illinois. Additional drilling has been recently completed west of the east branch of Lamarsh Creek. The area of coal affected by the sandstone seems to be confined to a strip of territory lying along the east side of the valley of the east branch of Lamarsh Creek and extending south of Lamarsh Creek along the bluff of the Illinois as far as Mapleton. A similar area where the sandstone cuts out the coal is reported in the vicinity of Wesley in Tazewell County.

The accompanying map (fig. 22) shows the status of information concerning the position of the channel sandstone south of Peoria and in Hollis and Limestone townships as worked out largely by Mr. W. C. Evans of Peoria by drilling and observation in mines.

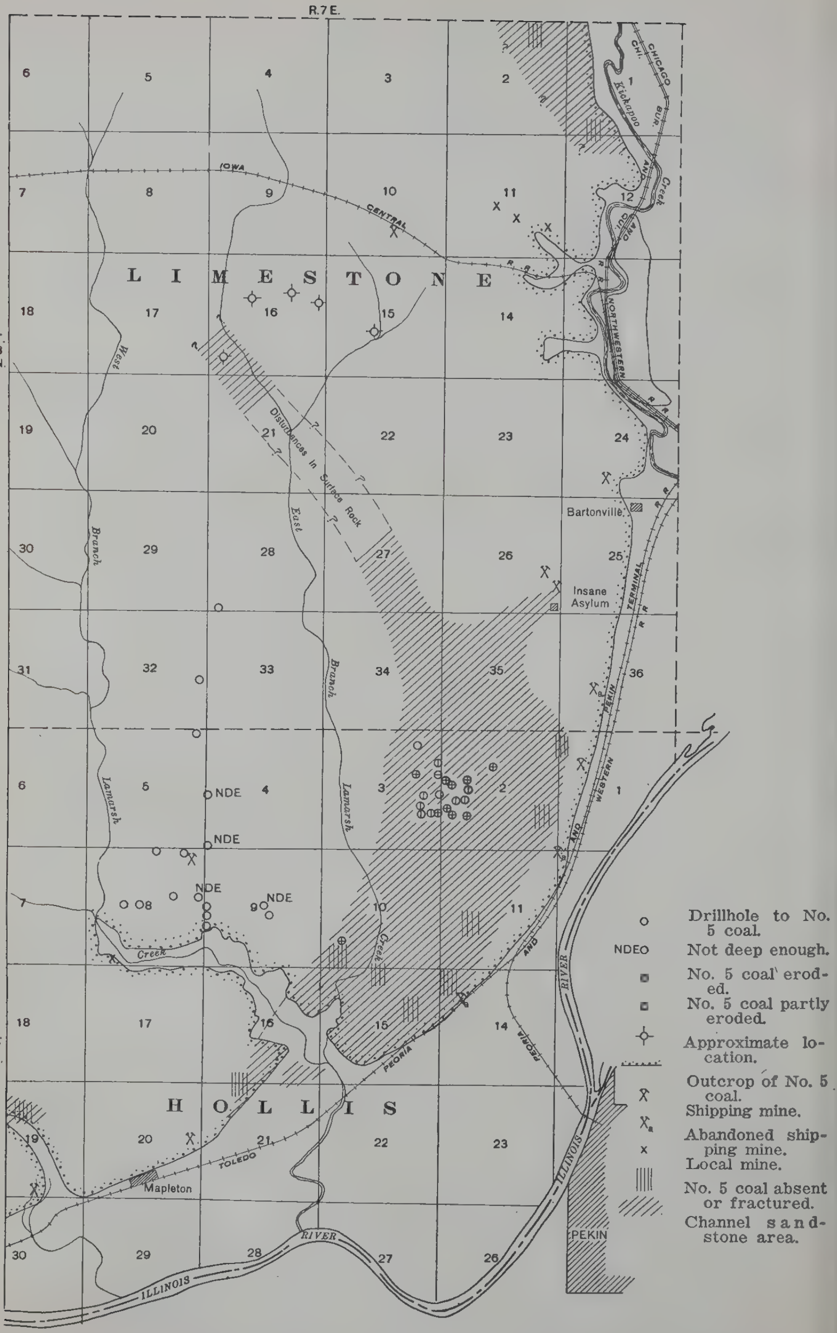

FIG. 22.—Map showing the position of the channel sandstone south of Peoria.

With the meager reports that are in existence concerning the succession of strata in the part of Peoria County outside of the Peoria quadrangle it is impossible to say that there are no other areas of channel sandstone in the county, penetrating the horizon of No. 5 coal. None of the mines located at Hanna, Glassford, or Kramms reports such "faults" in the area under operation. However, exploration of undeveloped coal land should be guided by the possibility of such an irregularity being present.

NO. 6 COAL

No. 6 coal lies in two benches, separated by a layer of clay known as the "blue band." Part of Udden's description[1] of this coal is cited herewith:

> "The lower bench varies from 1 foot 3 inches to 1 foot 8 inches thick. The 'clay band' as the 'blue band' is also called by the miners, is uniform and persistent, being absent in a few places, and is 2 to 3 inches thick. The upper bench of the coal is in many places partly destroyed. * * * Where intact, it measures 2 feet 1 inch to 2 feet 6 inches thick. In addition to this there is in places about 6 inches of bony coal, which was probably only locally deposited. * * * In places the lower part of the coal has two interrupted bands of marcasite, one about 5 inches from the bottom and the other 9 inches higher up. These measure one-fourth to one-half inch thick."

Field investigations, drilling, and some mining of this bed demonstrate that No. 6 coal is more uncertain in its distribution than No. 5. The seam varies greatly in thickness and in places seems to be entirely missing. The cause of its irregular distribution seems to be erosion subsequent to deposition rather than failure of deposition. In the case of No. 5 coal, the removal of the peat and absence of the coal was along rather well-defined lines of what were apparently the courses of stream channels. But the removal of No. 6 coal was seemingly along less definitely organized lines suggesting that possibly the irregularities in the coal are actually inheritances of irregularities in the original bog in the low parts of which there may have been open-water ponds and sluggish streams, these channels and ponds being ultimately filled with silt and sand. These conditions of deposition seem to have persisted over the entire area in which No. 6 coal was deposited in the State. The coal seems to have been more commonly affected by the irregularities in this region than in some parts of the State, but the general nature of the irregularities seems to be everywhere the same.

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[1] Op. cit., p. 33.

MC LEANSBORO FORMATION

STRATA BETWEEN NO. 6 AND NO. 7 COALS.

In Peoria County the strata composing the McLeansboro formation include all the rocks between the drift and No. 6 coal. No. 7 coal, one of the widespread coal beds of the State, which in the Danville and Longwall districts is of workable thickness, occurs 25 to 30 feet above the base of the formation, but in this district is nowhere of commercial thickness.

The strata overlying No. 6 coal vary considerably. The normal succession, occurring where the entire section is present, consists of a gray shale, in places dark gray, 18 inches to 2 feet thick, overlain by limestone averaging a little more than 2 feet and in sixteen measurements, according to Udden, ranging from 3 inches to 4 feet. In many places the shale above the coal is replaced by a variable sandy deposit known among the miners as "white top." Udden expresses the opinion that this deposit is of much later age than the strata it replaces or between which it is inclosed and suggests that it originated as cave wash in solution cavities located in the under part of the limestone cap-rock, erosion in which also affected the upper part of the coal bed.[1] The present writer, on the other hand, is of the opinion that the sandy shale composing the "white top" represents deposits in depressions in the original peat bog. It is believed that the lack of well-defined bedding in these deposits and the presence of slickensided surfaces and partings and the conchoidal fracture of the material which Udden cites as evidence of the "cave" origin, were produced as a result of the "kneading" to which the deposits were subjected because of the differential shrinkage of areas of the peat of considerably different thickness. The shrinkage of a bed of peat to coal now about 4 feet thick would be in some proportion ranging between 32 to 1 and 3 to 1, 5 to 1 being apparently the approximate average proportion that holds for Illinois coals. It is clear that if the coal in places is 4 feet thick and in other places because of the presence of a lenticular body of shale embedded in its upper part only half as thick or less, movement must have taken place to adjust the strains that resulted from differential shrinkage of the thick and thin peat. As a result of the readjustments that must take place in the lens of sandy shale or "white top" this material will be "kneaded" and fractured and will tend to lose much if not all of its originally laminated structure. The material will accordingly furnish a very treacherous roof because of lack of coherence. Not uncommonly the strains are carried downward into the coal, fracturing and displacing it, especially along the edge of the "white top" masses.

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[1] Op. cit., pp. 84-85.

The cap-rock of No. 6 coal is fairly continuous, apparently even more continuous than the coal itself. The rock is an impure argillaceous limestone, the lime content of which does not appear to comprise much more than half the rock. It does not have the appearance of a rock that would develop large cavities by the action of ground water. Udden[1] describes the rock as follows:

> "Clay seams separate it into four or five beds of unequal thickness. In places the middle beds weather into blocks a foot and a half thick. The thin top layer is in places separated from the other beds by a seam of clay measuring several inches.
>
> "The rock is light gray in color. In places it exhibits an indistinct nodular or concretionary structure, the nodules measuring one-half to one inch in diameter, but this is not general. With the aid of a lens nearly one-third of the mass of the upper beds is seen to consist of organic fragments, representing mostly brachiopods, crinoids, and *Fusulinas*. These lie embedded in an apparently structureless calcareous matrix. Many of the shell fragments are appreciably rounded. Fragments of *Fusulina* can be found in every piece of rock. Another constant characteristic is the presence, especially in the upper beds, of black nodular lumps impregnated with bituminous material. They are sharply delineated from the matrix and exhibit a rough exterior surface. In many places they contain fragments of shells and appear to conform to the structure of the limestone itself. In size they vary from a mere speck to masses 2 inches in diameter. Generally they are three-fourths of an inch in diameter and slightly flattened. In the upper beds there are in places rounded pieces of calamarian stems, which are also black from impregnating bituminous material and exhibit a coarse cellular tissue."

In Illinois the fossil *Fusulina* (now known as *Girtyina*) mentioned in the foregoing quotation is apparently restricted in its occurrence to the limestone cap-rock of No. 6 coal and to a limestone supposed to occur several hundred feet above No. 6 coal and found only in the eastern part of the State. The fossil has somewhat the appearance of a short thick oat grain. Because it is almost invariably present in every piece of the rock down to the size of a walnut and is rather readily found, it serves as an accurate and practical method of identifying this limestone and the coal a short distance beneath it.

Above the limestone is light-gray or greenish shale or "soapstone" above which is a massive sandstone, but which ranges in thickness from 10 to 25 feet but averages about 20 feet. Between the sandstone and the fire clay of No. 7 coal is generally clay shale 1 to 8 feet thick. In some places this is dark greenish gray, and in others dark red or brown. This red clay Udden regards as an infallible guiding stratum for the coal beds of this region. Where present, it lies from 8 to 16 feet under coal bed No. 7 and no other red clay is exposed in the Pennsylvanian system in the Peoria region. It is noteworthy that a bed of variegated shales is also reported to be present in District VII[1] within 50 feet above No. 6 coal. As a rule in that area they lie a short distance above No. 7 coal.

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[1] Op. cit., p. 34.

NO. 7 COAL

No. 7 coal is generally present in the county except where it has been removed by erosion. It maintains a very uniform thickness of about 18 inches, which is insufficient to make the coal of commercial value, at least for many years.

Udden states that the coal is especially characterized by lenses of mineral charcoal commonly found near the top of the bed. In places the charcoal is impregnated with pyrite and appears as "sulphur cakes" or "blackjack."

STRATA ABOVE NO. 7 COAL

The roof of No. 7 coal consists of a few inches of gray soft shale resting upon the coal and above this, black shale in varying thickness from 6 inches to 2 feet. In some places the black shale rests directly upon the coal. Above the black shale there are in most places a few feet of slightly siliceous and micaceous shale. The overlying sandstone rests upon an uneven surface of sufficient relief to entirely eliminate the upper shale in many places so that it rests upon the underlying black shale and even upon the gray clay below. The sandstone varies in texture from sandy shale to sandstone. Generally the lower beds are coarser. Udden states[2] that about a mile west of Bartonville this sandstone is nearly 40 feet thick.

At the top of these sandy beds is about 6½ feet of dark shale, part of which is thought by Udden to represent an old soil. This is followed by a 20-foot limestone ledge, known as the Lonsdale limestone from its exposure at the old Lonsdale quarries. "The lower 5 feet of this rock consists of a firmly cemented largely organic limestone, in beds varying in thickness from 6 inches to 1½ feet." In places part of the rock consists "of a calcareous mud-lump breccia, in which regular lumps of a dark compact structureless carbonate of lime are embedded in a less pure, greenish-gray matrix. In this matrix fragments of fossils also occur." Above these firm beds there are 15 feet of a slightly argillaceous and more flaggy rock, in which concretionary structure can nearly always be detected.[3]

Above the limestone is a 15-foot sandstone which has only a limited distribution as has also the overlying dark shale, which is the uppermost Pennsylvanian stratum in the Peoria quadrangle. The general dip of the rocks toward the southeast makes it probable that the youngest "Coal Measures" rocks will be found in the southeast part of the county.

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[1] Kay, F. H., Coal Resources of District VII: Illinois Coal Mining Investigations Bull. 11, p. 24, 1915.

[2] U. S. Geol. Survey Bull. 506, p. 38.

[3] Op. cit., p. 40.

Deposits Above the Coal-bearing Rocks

The material overlying the Pennsylvanian strata consists either of alluvium or glacial drift, that is unconsolidated stony clay, and sand and gravel. Because the bed-rock surface was a land surface before glaciation, except for a relatively thin covering of soil and of alluvium along streams, it was affected by the ordinary processes of stream action which produced the usual organized lines of drainage with divides separating them. The glacial drift left by the continental ice sheet tended to cover up the inequalities in the surface overridden by the ice, and to produce a new surface with a relief originating in the unequal distribution and thickness of the drift. The drift has a bearing on mining operations because it conceals the form of the underlying rock surface and the character of the outcropping rocks, and renders the distribution a single stratum, such as a coal bed, difficult to determine without drilling.

The alluvium is confined to the valleys. The river which occupied the valley of the Illinois before glacial time flowed at a much lower level and at a position slightly different from that of the present river. The map of the pre-glacial surface (Pl. VI) shows the position of the pre-glacial valley and the altitude of the channel. It will be noted that the deepest part of this valley had an altitude of about 350 feet above sea level. As No. 2 coal lies at an altitude of about 300 feet in the vicinity of Orchard Mines and Pekin, it follows that this coal is probably very lightly covered with drift if not removed within the pre-glacial Illinois valley in the southern part of the county. What is possibly this coal is reported to outcrop below the valley fill beneath the bed of the river about opposite Kingston Mines.[1]

The wide area of deep filling at Peoria and up Kickapoo Creek and a similar area of thick drift across the Illinois in Fondulac Township, Tazewell County, and the general slopes of the old pre-glacial upland surface in Kickapoo, Limestone, and Hollis townships and in Groveland Township, Tazewell County, suggest to Udden[2] the possibility that the old upland was continuous across the valley at the position of present narrows between Bartonville and Hollis. This upland in that case would represent a divide between a stream crossing the course of the present Illinois in a northwest-southeast direction at about the position of Peoria and Kickapoo Creek and another stream farther south. Udden, however, presents another hypothesis to account for the narrows. "If the Illinois River valley antedates the glacial epoch, its narrow course between Iowa Junction and Pekin may be due to the comparatively more resistant sandstone above coal bed No. 5 which prevented as rapid recession of the bluffs on both sides of the valley as has taken place elsewhere."

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[1] Cooley, Lyman E., The Illinois River; physical relations and removal of the navigation dams: Sanitary District of Chicago, Chart opposite page 42, 1914.

[2] U. S. Geol. Survey Bull. 506, p. 52.

The character and position of the pre-glacial valleys in Peoria County that may exist outside of the area of the Peoria quadrangle have not been reported.

Outcrops along the west bluff of the Illinois are nearly continuous southward from Kickapoo Creek, and northward from Senachwine Creek at Chillicothe. Between Peoria and Chillicothe, however, the bluffs are composed of glacial till, representing remnants of the filling in the pre-glacial Illinois valley.

The Minable Coal of Peoria County

Udden states that no less than seven coal beds occur in the Pennsylvanian rocks of the Peoria region, of which only three are exposed. Of these seven, but four have commercial value, and of these four only three have been operated during the last calendar year. The beds of workable thickness are No. 1, No. 2, No. 5, No. 6, and No. 7. Of these only No. 5 is worked extensively on a commercial scale. One commercial mine has reopened workings in No. 2 coal, and several wagon mines operating No. 6 and No. 7 coal. The general character of these coals has been described in the section devoted to the geological succession in Peoria County. It remains to consider the coals from an economic viewpoint and to review the factors that affect its commercial value. These are distribution, thickness, chemical character of the coal, nature of impurities and irregularities, and character of roof and floor. The coals will be described in an order the reverse of that just used in discussion of the strata of the Pennsylvanian system.

NO. 7 COAL

No. 7 coal is not of workable thickness in the central and southern part of the county. Udden[1] states that the coal averages 1 foot 5 inches in the Peoria quadrangle, and that the uniformity of its thickness is remarkable in that area. Worthen[2] states in regard to this coal that:

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[1] Udden, J. A., Geology and mineral resources of the Peoria quadrangle: U. S. Geological Survey Bull. 506, p.36, 1912.

[2] Worthen, A. H., Geological Survey of Illinois, Vol. 5, p. 249, 1873.

"In the northern portion of the county, No. 7 is the principal coal outcropping above the valleys of the streams, and the lower seams can only be reached by shafts, or by an inclined tunnel carried down to their level. This seam ranges from two and a half to three feet in thickness in this part of the county, and its outcrop may be found on most of the small streams. It is very regular in its development, and affords a coal of fair quality where it is mined beyond the influence of atmospheric agencies."

The thickening of No. 7 coal northward in the northern part of the county and thence toward the Longwall District parallels a thinning of No. 6 coal in the same direction. In the northern district No. 6 coal is apparently absent, whereas No. 7 has a thickness of between 4 and 5 feet. In northeastern Peoria County north of Chillicothe, No. 7 coal has been worked at a number of wagon mines. In this vicinity the coal is about three feet thick. The Survey has little definite information in regard to the area underlain by No. 7 coal of workable thickness, or of the general mining conditions.

MINE NOTES, NO. 7 COAL

The following notes taken in Crew Brothers' mine north of Chillicothe in 1909 are given in lieu of more adequate data.

CREW BROTHERS' LOCAL MINE, NEAR CHILLICOTHE

Entrance: Drift; No. 7 coal.
Thickness of coal: Varies from 2 feet to 3½ feet; averages 3 feet.
Section of the coal:

Section of No. 7 coal in Crew Brothers' mine, near Chillicothe

	Thickness	
	Ft.	*in.*
Roof: Black slate, or soapstone	..	..
Coal	..	10¾
Trace of clay	..	..
Coal	..	6½
Trace of clay	..	..
Coal	..	6
Parting	..	..
Coal	..	7¼
Mother coal and trace of pyrite	..	1
Coal	..	4
Floor: Fire clay	..	..
	2	11½

Character of the coal: The seam is fairly uniform throughout. The bottom coal, below the mother coal, and the coal just above the mother coal are somewhat harder than the other benches. The trace of pyrite in the mother coal is persistent throughout the mine. It was called the "blue band," but is not to be confused with the well-known "blue band" so characteristic of No. 6 coal.

Character of the roof and floor: The roof is a black shale or "slate" which is in places replaced by "soapstone." There was no limestone present as a cap-rock. The floor is fire clay.

NO. 6 COAL

As No. 6 coal lies at an altitude of about 550 feet in the Peoria region, it is consequently above the level of the Illinois and of Kickapoo Creek for a considerable distance above the mouth of the Kickapoo. In western Peoria County at Elmwood No. 6 coal is below stream level and has an altitude of about 575 to 600 feet. It has about the same altitude at Princeville. It is apparent that most of the county is underlain by this coal, that it is generally under sufficient cover and with roof undisturbed, so as to be accessible for drift mining in many places, especially along Kickapoo Creek.

The coal possesses certain characteristics which stand in the way of its general exploitation. It is more irregular in its development than any of the other coals and principally for this reason it is generally neglected. Worthen states in regard to this coal that "When fully developed it is quite as thick as No. 5, but the miner who commences drifting into this coal on a promising outcrop from four to five feet in thickness, will frequently, in a distance of a hundred yards or less, find the coal gradually thinning out to one-half its original thickness."[1] Apparently the coal is more persistently developed in workable thickness in the northwestern part of the county than in the southern or eastern part. Along the Illinois valley northward from Chillicothe it seems to be thinner than No. 7 and has not been much worked.

Roof conditions also present difficulties in the working of the coal that are not easily overcome. The regular normal roof is shale, commonly gray, but in places nearly black, 6 inches to possibly 3 feet thick, above which is a persistent cap-rock, averaging about 2 feet thick in the Peoria quadrangle but ranging from 3 inches to 4 feet. It is possibly considerably thicker in some places in the northern part of the county. Notes taken about ten years ago in a mine located near Brimfield state that 25 to 30 feet of limestone are present in that locality. Under normal roof condition no serious difficulties are encountered. The roof shale, which is commonly a foot or less in thickness, usually falls soon after the coal is extracted, leaving a good hard limestone roof. The expense of removing the shale is considerable, of course, but the cost of its removal can be fairly well estimated, so that it can be anticipated before a project is started. The usual roof, however, is in many places replaced by "white top," the nature and possible cause of which were discussed on an earlier page. It is sufficient to restate here that this material appears to be the sand and sandy mud filling of depressions existing in the original peat swamp, later covered along with the rest of the area, by the limestone cap-rock. Adjustments that were necessary because of the differential shrinkage during the change of the peat and sands to coal and rock destroyed the original structure of the sandy lens, "kneading" and crushing them until they now lack coherence and are very difficult to hold. Moreover, the adjustments commonly produced fractures in the coal and weakened the overlying limestone. The total result is a roof condition generally above thin coal that is extremely undesirable, as it is dangerous and costly to provide for. No system of distribution of the "white top" has been discovered. It is usually present to some extent in any body of coal large enough to be worked, and mines have been worked until the poor roof conditions exist in half or more of the workings. Profitable mining is impossible, however, under these conditions.

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[1] Worthen, A. H., Geological Survey of Illinois, Vol. 5, pp. 249-250. 1878.

It is apparent that commercial exploitation of No. 6 coal in this region is not to be considered while No. 5 coal is present in large blocks suitable for mining. It is possible that some system more suitable for operating the No. 6 coal than the room-and-pillar method can be employed, designed to meet the uncertainties that exist, and it is possible also that careful investigation of white top in the region may reveal some system of distribution the discovery of which will assist in devising a suitable method for the extraction of the good coal. At present no block of this coal should be considered for development without intensive drilling to determine the roof conditions and the thickness of the coal.

No. 6 coal is characteristically divided into beds or benches wherever it occurs in the State. Partings and seams of clay, mother coal, or pyrite are generally present and in this county apparently always present to subdivide the bed into benches. Udden describes the bed as subdivided into only two benches by the clay seam or "blue band," a seam of clay or shale ½ to 3 inches thick, found 12 to 14 inches from the bottom and 33 to 46 inches from the top of the coal. Where the white top is present more or less of the upper bench is absent, so that the thickness of this bench varies considerably. As a general thing it is believed that the bottom bench is undisturbed. Observations in various local mines indicate that bedded impurities other than the clay or blue band are very persistent at least locally. A rather continuous band of "sulphur" of clay lies in the lower bench generally in the upper half. It is not always possible to identify blue band with certainty where both of these bands are present, as they are commonly quite similar. The upper bench, above the blue band, commonly contains several thin partings. One, 12 to 18 inches from the top, seems to be fairly persistent in the mines in the northern part of the county, others are of local distribution, not being persistent even throughout the workings of a single small mine. The total effect of these various impurities is to make the coal as produced rather dirty, although the individual benches between the partings are clean coal. The task of mining clean coal by carefully separating the dirt from the coal in the mine is rather exacting upon the miner and it is doubtful whether it can generally be effectively accomplished. Mechanical separation by washing or other means would probably produce much cleaner coal than the usual mine-run output.

The occurrence of pyrite ("sulphur") in bands and thin lenses is characteristic of No. 6 coal nearly everywhere in the State except in the area of low-sulphur coal in southern Illinois. This sheet or plate pyrite is commonly of either a bright or a stony dull variety, compact and structureless. As its separation from the coal is comparatively easy, this coal is more readily cleaned of its sulphur than other beds in which lenticular laminated gray or brown pyrite is found. The fact that the pyrite commonly occurs in the partings makes it all the more readily extracted at the face.

Observations in a few of the local banks indicate that this coal like No. 5 is cut by clay veins or horsebacks. They are not so common, however, as to be typical of the bed, and do not represent a serious impurity in the coal as is commonly the case in No. 5.

The floor of this coal is fire clay, with no peculiar characteristics so far as is known.

MINE NOTES, NO. 6 COAL

The following observations were made in a few mines in the county operating No. 6 coal. Some have since been abandoned and all were local operations at the time the observations were made.

BERRY BROTHERS' WAGON MINE, NEAR BRIMFIELD IN THE SW. ¼, NW. ¼, SEC. 5, T. 10 N., R. 6 E.

Entrance: Shaft; depth to No. 6 coal about 35 feet.

Thickness of coal: Varies from 2 feet to 4 feet 9 inches; averages 3 feet 3 inches.

Section of the coal:

Section of No. 6 coal, Berry Brothers' mine, near Brimfield

	Thickness	
	Ft.	*in.*
Coal (top coal)	1	6
Pyrite	..	½
Coal	1	..
Clay band ("blue band")	..	2
Coal	1	..
Pyrite	..	½
Coal	1	..
	4	9

The best coal in the above section is the upper 30 inches. The two bands of pyrite noted are persistent throughout the workings.

Character of the coal: The general succession is indicated by the above generalized section. Clay slips or "horsebacks" are common and there is considerable "white top" present. The coal dips to the northeast about 1 per cent, and one small fault with 2½ feet displacement was noted.

Character of the roof: The normal roof is gray to black shale which falls with the coal, with a limestone cap-rock above. The small fossil Girtyina was identified in fragments of this rock, which establishes the identity of the coal.

Character of the floor: The floor is described as fire clay. No unusual characteristics were noted.

TAYLOR AND SONS' WAGON MINE AT PRINCEVILLE,
NW. ¼, NW. ¼, SEC. 24, T. 11 N., R. 6 E.

Entrance: Shaft; depth to No. 6 coal about 75 feet.

Thickness of coal: Varies from 2 feet to 5 feet 2 inches; averages 4 feet 8 inches.

Sections of the coal:

Section of No. 6 coal in Taylor and Sons' local mine at Princeville
1st room off 1st west entry, 500 feet from shaft

		Thickness	
		Ft.	*in.*
1.	Coal	..	2½
2.	Parting	..	..
3.	Coal	..	10
4.	Clay parting	..	⅛
5.	Coal	..	¼
6.	Clay	..	⅛
7.	Coal	..	10
8.	Pyrite	..	¼
9.	Coal	..	4½
10.	Clay	..	¼
11.	Coal	..	6¾
12.	Clay ("blue band," called clay band)	..	2¼
13.	Pyrite	..	½
14.	Coal	..	7
15.	Clay (called "blue band")	..	½
16.	Coal	..	6
17.	Pyrite	..	½
18.	Coal	..	7
		4	10½

Character of the coal: Of the partings noted in the preceding section of the coal, numbers 4, 8, 12, 15 and 17 are persistent. As the section indicates, the coal is rather dirty because of the numerous bands of impurity. The coal between the bands, however, is clean.

Character of the roof: The immediate roof is a black to gray carbonaceous shale spoken of as "ramble." This is about 6 inches thick and above it is the limestone cap-rock. The shale falls with the withdrawal of the coal, leaving a firm hard limestone roof. No record is made of the presence of "white top" in this mine.

Character of the floor: An impure coal composed of a mixture of mother coal and shale commonly is present in the bottom of the bed to a thickness of 6 inches or less. Below this material fire clay is reported to be present.

WAGON MINE, LOCATED BETWEEN GLASFORD AND HANNA, SW. ¼ SE. ¼ NE. ¼, SEC. 34, T. 8 N., R. 6 E.

Entrance: Drift; No. 6 coal.

Thickness of coal: Average 3 feet 10 inches.

Section of coal:

Section of coal in local mine, north of Glasford

	Thickness	
	Ft.	*in.*
Limestone with many *Girtyina* ....3 feet to	4	..
Shale, gray ....4 inches to	..	8
Coal	2	..
Blue band........1½ to 3 inches, average	..	1
Coal	..	3
Pyrite lenses ....up to	..	3
Coal	..	5
Clay band ....¼ inch to	..	½
Coal	..	9½
Fire clay	..	..
	3	10

NO. 5 COAL

No. 5 coal is the most valuable bed in the county. Its desirability rests upon its fairly widespread occurrence, its uniform thickness, the satisfactory mining conditions under which much of it can be worked, and the absence of impurities that can not be removed by careful mining. In places, however, conditions exist that render the cost of mining prohibitive of profit, or that affect the quality of the coal in such a way as to render it unmarketable. These conditions are local, however, being far from common enough to condemn the whole body of coal.

Conditions which affect the distribution of the coal have already been described at some length earlier in this bulletin, in the discussion of the strata between No. 5 and No. 7 coals. The attention of the reader who is especially interested in the irregularities in the distribution of the coal is therefore directed to the discussion on pages 161 to 163, and 165 to 175. It may be repeated here that uncertainties with respect to the distribution of the coal that are of significance in the development of new properties are of two sorts. One results from the lack of definite information with regard to the position and depth of lines of pre-glacial drainage, and the other from the undetermined extent and distribution of certain bodies of sandstone, which have been termed channel sandstones, and which lie across the position of No. 5 coal.

Udden states that the average thickness of No. 5 coal is 4 feet 4 inches for the Peoria quadrangle. This is probably a fairly accurate estimate for the entire county, although no figures are available concerning the thickness of this coal in the northern part where No. 6 rather than No. 5 coal is being mined at local banks. The coal shows a variation in thickness of not over 5 to 6 inches in each area where it is worked. In the places where it departs from the usual thickness, the bed more commonly tends to be thinner rather than thicker than the average. The more common variations in thickness, however, are apparent rather than real, being due to small faults accompanied by a slight displacement at the position of the clay slips or horsebacks. When the plane of movement is inclined, the result is to produce an apparent thinning of the bed when measured vertically across the fault plane (fig. 23). Such slight displacements at horsebacks are the most frequent cause of variations in thickness of the No. 5 coal.

The irregularities in No. 5 coal that are the most continual source of difficulty and expense are the horsebacks, both clay slips and "sulphur spars." The number of these differs considerably in different parts of the county, some mines encountering them in great numbers, whereas other mines find so few that they are of little consequence. The mines in Hollis and Limestone townships, except those west of Mapleton, seem to be more troubled by the horsebacks than those farther west at Glasford, Hanna, and Edwards.

The Peoria County horsebacks are similar to those described in Fulton County and to those that occur elsewhere in this district. At least for a short distance above the coal the coal bed and overlying strata have been fractured and in some instances offset along the fracture. The planes of fracture are generally nearly vertical and rarely if ever inclined more than 45 degrees. Opposite sides of the fractures, along which there has been no movement to offset the bed, are roughly parallel. The fractures themselves have been filled with clay, which apparently has been forced into them, or with vein pyrite where they are very narrow. The upper layers of the coal next to the fractures that are clay filled have commonly been forced downward, and fragments of roof shale are found in the fissures below the top of the coal, indicating that the clay has been forced in from above. This relationship possibly does not always hold and possibly is of no great significance, for whether the clay originated below or above the coal it obviously is forced into the fissures in the coal as an adjustment of inequalities in pressure which probably are responsible for the fracturing.

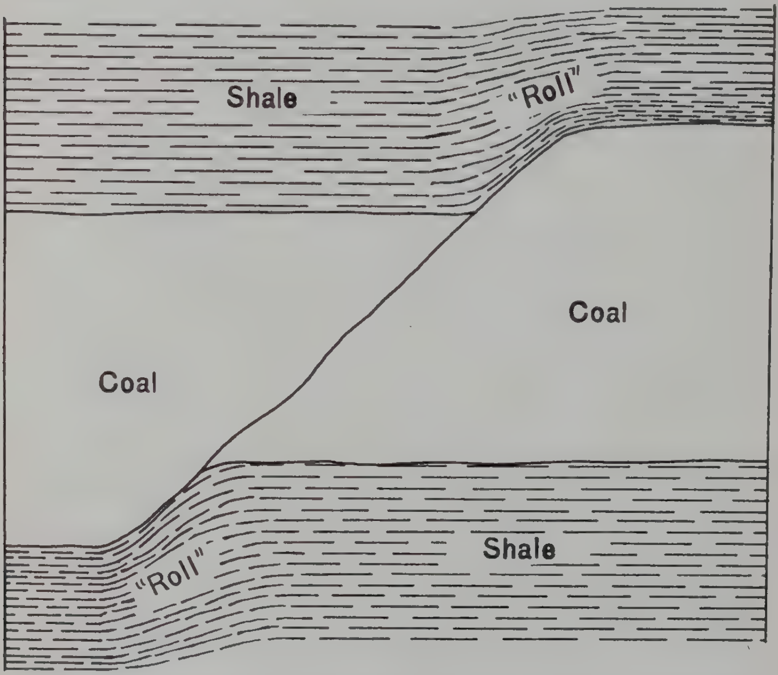

FIG. 23.—Diagrammatic sketch showing the manner in which faulting along a horseback will effect an apparent thinning of the coal bed.

Where these horsebacks are present, production of clean coal and the support of the roof near the fractures are difficult. The first difficulty is met by discarding all the coal affected by the horseback. The clay veins are generally rather heavily impregnated with pyrite which also fills many of the smaller cracks in the coal adjacent to the main fissure, so that the horseback and some attached coal on either side is usually removed in large pieces. The expense of removing the horsebacks is indicated by the following agreement between the operators and miners of the Second Sub-District, dated April 1, 1918:

> "Eighteen—That all horsebacks, rolls, or slips, marking the coal two to six inches average width in the center of such horseback, roll, or slip, whether coming from top or bottom, shall be $2.80, and 23 cents for each additional inch thereafter.
>
> "When a slip, roll, or horseback continues with the working place more than the width of such working place, it shall be paid for at the same rate, as long as it continues with the said working place."

The coal removed and wasted by this method of handling the horsebacks amounts to a very considerable proportion of the coal mined in some operations.

The second difficulty noted above, that of supporting the roof near horsebacks, is a very serious one. If the cracks are numerous and rather wide, so that the cohesion of the cap-rock is weakened, the strata are almost impossible to hold. Horsebacks that run with an entry not uncommonly cause "falls" their entire length of many feet. Such conditions of course make the expense of mining very high. There is apparently no systematic attempt in any of the mines to remedy the conditions. They are met as they arise and the success or failure of a mining enterprise depends largely upon the company's fortune in striking a good or bad piece of coal. Unfortunately drilling does not assist much in determining the frequency of the horsebacks. The prospector for new resources is dependent upon information gained at outcrops, in local banks, and in mines adjacent to the property under consideration.

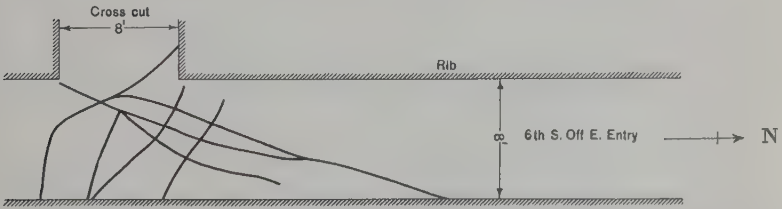

FIG. 24.—Sketch showing the cracks cutting the roof along the 6th southeast entry of the Leitner Coal Company's mine.

The accompanying sketch (fig. 24) of the cracks cutting the roof along one entry of the Leitner Coal Company's mine will give some idea of the frequency of the horsebacks in some mines in the region.

The "sulphur spars" are nearly as expensive and possibly more troublesome to handle than the clay veins. The pyrite is true vein filling which not only occupies the space opened by the fissure but ramifies the adjacent coal along small cracks and cleavage planes. The result is a mass of hard coal commonly extending as much as four inches either side of the main vein. This material is exceedingly hard to cut and is more objectionable to the miner than the clay veins, although the latter are larger.

"Sulphur" or pyrite other than that found in the sulphur spars is an impurity of varying importance. In some mines it is very common and its removal a matter of considerable difficulty. In other mines it is of small consequence. In general the sulphur is more common in those mines in which the coal bed is crossed by numerous horsebacks. The pyrite is principally of two kinds: the bright brassy variety commonly found near the roof or in the upper part of the coal; and the brown or gray pyrite lenses. The former is present in about the same amount in all the mines irrespective of the number of horsebacks present; the latter is distributed in greater abundance near horsebacks, and especially near the clay veins. The gray or brown sulphur occurs as lenticular masses with indistinct outline and grayish color, and apparently consists of interlaminated pyrite and carbonaceous material. Many of the gray pyrite lenses widen out toward a contiguous clay vein, attaining their greatest size at the contact. The lenses are not uncommonly 4 inches thick at the thickest part and extend laterally as much as 3 or 4 feet. This material is supposed to be rejected by the miner, a docking system being in force to encourage the loading of clean coal. The laminated pyrite seems to have an origin dependent in some manner upon the fissuring and therefore constitutes additional difficulty with which the mines having numerous horsebacks must contend. In themselves, however, they are not a very serious impurity, and do not greatly affect the value of the coal.

Some of the mines, in addition to the varieties of pyrite already described, have a streak or thin lens of pyrite from one-eighth to one inch thick and about half an inch above the bottom of the coal. This sulphur comes up with the bottom coal and is then broken off, together with more or less attached coal. Not uncommonly, likewise, the lens or mass of limestone lying between the coal and the "slate" and carrying many fossils is generally replaced to considerable extent by pyrite so that the fossils and texture of the rock are preserved in pyrite rather than limestone. The "niggerheads" in the black "slate" are also pyritized, though commonly only in a zone at the surface. In some of the mines south of Peoria a discontinuous layer of "brown" pyrite is present about midway in the bed.

The typical roof of No. 5 coal in this county as elsewhere is a succession of black "slate" about 1 foot thick, above which is about 12 inches of gray clay or clod, and 8 to 12 inches of cap-rock. The thickness of the cap-rock may vary considerably from this figure, but as it usually stays up, its general thickness is not accurately determinable. Except where broken by fissures the roof is very satisfactory.

Over part of the coal is a massive, substantial sandstone roof. This roof is most commonly found near the "faults" or channel deposits that have been described. The coal is not essentially different under the sandstone from what it is under the shale. Under each variety of cover it has the usual horsebacks and other irregularities, the fissures continuing up into the roof whether it be sandstone or shale.

The floor is a fire clay of the usual character and gives no special difficulties.

MINE NOTES, NO. 5 COAL

The following observations are presented with the idea that they will throw light on conditions in local areas in the field.

LOGAN COAL COMPANY'S NO. 1 MINE AT HANNA CITY

Entrance: Shaft; about 236 feet to No. 5 coal.
Thickness: About 3 feet 4 inches.
Sections of the coal:[1]

Sections of coal bed in Hanna City mine

Section	A		B		C		D	
Laboratory No.	22982		22983		22984		22985	
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
Roof, shale 2½ feet.....	..	..	..	..	..	..	..	..
Coal, bony	..	6*	..	..	..	..	..	6*
Coal, bright	1	6	1	0	3	3	1	0
"Sulphur" to "mother coal"	Streak		..	¼*	..	..	Streak	
Coal, hard	1	4	2	3¾	..	..	1	10
Floor, underclay	..	..	..	..	..	..	..	..
Thickness of bed.......	3	4	3	4	3	3	3	4
Thickness of coal sampled	2	10	3	3¾	3	3	2	10

*Not included in sample.

Character of the roof and floor: Roof is a hard gray shale about 2 feet 6 inches thick; the floor is underclay 3 to 5 feet thick.

Samples were collected at the places where the sections were made and analyzed by the U. S. Bureau of Mines,[2] and the results are reprinted as a part of Table 3 of this report.

CLARK COAL AND COKE COMPANY'S EMPIRE (NO. 2) MINE AT PEORIA

Entrance: Shaft; depth to No. 5 coal, 180 feet.
Thickness of coal: Varies from 3 to 4½ feet; average 4 feet.
Sections of the coal:

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[1] U. S. Bureau of Mines Bull. 123, p. 179.
[2] U. S. Bureau of Mines Bull. 123, p. 35.

Empire Mine

Sections of No. 5 coal in the Clark Coal and Coke Company's

Section 1—First butt entry off 11th east entry

	Thickness	
	Ft.	*in.*
Coal	..	7½
Soot seam	..	..
Coal	..	11½
Soot seam	1	10
Coal	..	8½
	4	1½

Section 2—Face 13th entry off main south entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean	..	11
Mother coal parting	..	⅛
Coal, clean	..	3
Mother coal	..	⅛
Coal, fairly clean	2	¾
Floor: Fire clay	..	..
	3	3

Impurities: Pyrite in vertical streaks and a few horizontal streaks of mother coal.

Section 3—Room 3, 7th south entry off 11th west off straight south

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, fairly clean	3	5
Bone	..	⅜
Coal, clean	..	1¼
Bone	..	⅜
Coal, clean	..	5½
Floor: Shell coal and fire clay	..	..
	4	1

Impurities: Bone and mother coal in horizontal streaks; calcite in vertical streaks.

Section 4—Face, 3d north entry off 1st west off straight south

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean, bright	1	1¾
Mother coal	..	¼
Coal, fairly clean, slightly streaked	..	11½
"Sulphur"	..	½
Coal, fairly clean	1	½
Bone, lens	..	½
Coal, fairly clean	..	11
Floor: Fire clay	..	..
	4	2

Impurities: Calcite in joint cracks; pyrite in vertical streaks; mother coal and pyrite in horizontal streaks.

Character of the coal: The coal is described by the observer who measured section No. 1 as tough, hard to break, and uniform in quality throughout with no definite line of impurity. Occasional sulphur balls and the clay slips characteristic of No. 5 are present, but not common.

Character of the roof: Above the coal is 2 inches of "draw slate" followed by 1 to 2 feet of dark "slate," in places containing a limestone band or cap-rock up to 18 inches in thickness. Sandstone overlies the black shale and where the shale is thin it always falls. Niggerheads are common in the roof shale.

CRESCENT COAL COMPANY'S NO. 1 MINE ABOUT 3 MILES NORTH OF BARTONVILLE

Entrance: Shaft; 195 feet to the top of No. 5 coal.
Thickness of coal: Average thickness 4 feet 2 inches.[1]
Sections of the coal:

Sections of No. 5 coal in the mine of the Crescent Coal Company

Section 1—Face of the 5th southeast entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, fairly clean	..	10
Mother coal and dirt	..	¼
Coal, dirty	3	6
Floor: Dark gray shale	..	..
	4	4¼

Impurities: Coal contains pyrite, mother coal and dirt in horizontal streaks with calcite in the joint cracks.

Section 2—Face off room 22, off 6th north entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, fairly clean	1	10½
Pyrite parting	..	⅛
Coal, fairly clean	1	2
Mother coal, soft	..	⅜
Coal, dirty	1	..
Floor: Dark gray shale	..	..
	4	1

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[1] Thirty-sixth Annual Coal Report of Illinois: Department of Mines and Minerals, 1917, p. 84.

Section 3—Face of 10th south, off west entry

	Thickness Ft.	in.
Roof: Black shale	..	..
Coal, clean	..	10½
Mother coal	..	⅛
Coal, dirty, dull	1	2
Mother coal	..	⅜
Coal, dirty, dull	1	2
Mother coal	..	⅝
Coal, fairly clean	2	1
Floor: Dark gray shale	..	..
	4	2

Impurities: Pyrite, mother coal and dirt in horizontal streaks; pyrite in vertical streaks.

COLLIER CO-OPERATIVE COAL COMPANY'S NO. 1 MINE, AT BARTONVILLE

Entrance: Slope; 110 feet to floor of mine.

Thickness of coal: Varies from 4 to 4½ feet; averages 4 feet 3 inches.

Sections of the coal:

Sections of No. 5 coal in mine of Collier Co-operative Coal Company

Section 1—Room 45 off 10th entry off main north; 3,300 feet southeast of shaft

	Thickness Ft.	in.
Roof: Black shale	..	18
Coal, clean	4	1
Floor: Fire clay	1	8
	7	3

Section 2[1]—At face of 6th north entry off main west entry

	Thickness Ft.	in.
Roof: Dark shale	..	..
Coal, conchoidal fracture	..	5
Coal, rough fracture	3	7
Coal and "sulphur"	..	1*
Floor: Brittle clay	..	..
	4	1

Section 3[1]—At face of room 1, 4th north entry in by 3d north parting

	Thickness Ft.	in.
Roof: Dark shale	..	..
Coal, conchoidal fracture	..	7
Coal, rough fracture	1	1
Coal and "sulphur"	..	¼*
Coal	2	6¾
Floor: Brittle clay	..	..
	4	3

*Not included in sample.

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[1] See footnote 1, page 195 opposite.

Section 4[1]*—At face of 5th north entry off main west entry*

	Thickness	
	Ft.	*in.*
Roof: Dark shale	..	..
Coal, conchoidal fracture	..	6
Coal, rough fracture	3	7
Coal and "sulphur"	..	½
Floor: Brittle clay	..	..
	4	1½

Character of the coal: The bed is reported to be fairly uniform with few horsebacks and no rolls or faults.

Character of the roof and floor: The roof is dark shale about 10 feet thick, above which is a limestone cap-rock, having an irregular surface. The floor is a brittle underclay.

The analyses are of samples collected where the sections Nos. 2, 3, and 4 were measured by the U. S. Bureau of Mines.[2]

M. E. CASE COAL COMPANY'S NO. 1 (WALBEN) MINE, SOUTH OF PEORIA

Entrance: Drift; about 16 feet to the top of No. 5 coal.

Thickness of coal: Averages 4 feet 7 inches. The coal thickens greatly near the sandstone "fault,'' but elsewhere its thickness is very uniform.

Sections of the coal:

Sections of No. 5 coal in Walben mine of the M. E. Case Coal Company
Section 1—Room 43, 7th south off 6th west

	Thickness	
	Ft.	*in*
Roof: Sandstone	..	..
Coal	1	8¾
Clay and pyrite	..	½
Coal	..	6½
Clay and pyrite interlaminated	..	¼
Coal	2	..
Floor: Fire clay	..	..
	4	4

Section 2—End of 7th south off 6th west

	Thickness	
	Ft.	*in*
Roof: Black slate	..	..
Coal	1	9
Pyrite and clay intimately laminated	..	½
Coal with some streaks of clayey mother coal	2	½
	3	10

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[1] Fieldner, A. C., Smith, H. I., et al, Analyses of mine and car samples of coal collected in the fiscal years 1913 to 1916: U. S. Bureau of Mines Bull. 123, pp. 178, 179, 1918.

[2] U. S. Bureau of Mines Bull. 123, p. 35.

Character of the coal: The coal is uniform in its general characteristics. The bed commonly carries a layer of intimately interlaminated pyrite and carbonaceous clay known as brown "sulphur" about 2 feet below the top, but this impurity is not persistent. Horsebacks are common and are of some special interest because the breaks generally continue up into the sandstone which lies upon or a short distance above the coal. In the 3d west entry off the 4th south, the sandstone at one place showed an open crevice above a horseback out of which the gage has fallen for a height of 15 to 20 feet. Clay shale shows in the top of the crack. It was not clear whether the clay was a continuation of the filling or a shale bed above the sandstone. The crack looked like a crack that had been produced or at least widened by weathering, the sides being rounded, or smoothed rather than clean and sharp. There was essentially no offset of any of the beds.

Below the horseback the clay floor is commonly raised in a ridge suggesting that probably there was some movement of the floor clay into the crack when it opened. The character of the lower clay is quite different from that filling the larger part of the fissure, this material apparently coming from some strata above the coal. These rolls in the floor clay are taken up by the miner, for which extra pay is given.

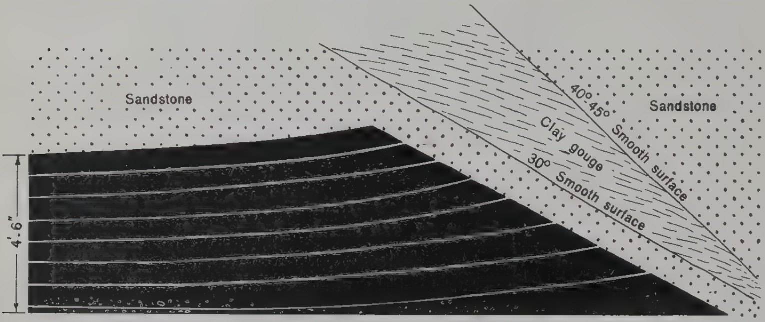

FIG. 25.--Sketch of the contact of coal and "fault" in the 6th west off main north entry of the M. E. Case Coal Company's No. 1 (Walben) mine

The operation of this mine is limited on the west by a sandstone "fault" which cuts out the coal (fig. 22). The sandstone apparently occupies a channel which penetrates the coal bed. The rock is a gray micaceous sandstone of about the same character as that forming the roof of much of the mine. At some places the coal feathers out under the sandstone and at others it terminates very abruptly against the sandstone. The nature of the contact at one place along the "fault" is shown by the accompanying sketch (fig. 25).

Character of the roof: The immediate roof varies from the usual succession of black "slate," clod and cap-rock to merely sandstone. The sandstone apparently lies irregularly upon the underlying strata, in places resting directly upon the coal and in other places separated from the coal by a greater or less thickness of the typical roof.

Character of the floor: The underclay, about 18 inches thick, is underlain by an "iron band" 10 inches thick. The clay heaves somewhat in wet places, and the clay tends to "roll" up in the floor beneath the horseback fissures, rising nearly 12 inches in some cases.

LEITNER COAL COMPANY'S NO. 1 MINE, NORTHEAST OF ORCHARD MINES

Entrance: Drift mine; No. 5 coal.

Thickness of coal: Varies from about 4 feet to 6 feet; averages 4½ feet. The coal thickens markedly near its contact with the sandstone "fault" (fig. 15); elsewhere it is practically uniform in thickness.

Sections of the coal:

Sections of No. 5 coal in the Leitner Coal Company's mine
Section 1—6th south entry

	Thickness	
	Ft.	*in.*
Roof: Black slate	..	..
Coal, laminated, and with thin streaks of mother coal	1	7½
Pyrite; mixture of clay, organic matter and pyrite. Called "brown sulphur" by miners	..	3
Coal, like top coal	2	10½
Pyrite or clay, hard	..	½
Coal	..	½
Floor: Fire clay	..	..
	4	10

Section 2—5th south entry.

	Thickness	
	Ft.	*in.*
Roof: Black slate with coal stringers	..	..
Coal	..	11½
Pyrite and clay	..	2
Coal	1	½
Pyrite and clay	..	2
Coal	2	11
Pyrite streak in bottom	..	..
Floor: Fire clay	..	..
	5	3

Section 3—Face main west entry

	Thickness	
	Ft.	*in.*
Coal	1	4
Pyrite and clay	..	2½
Coal	2	6
	4	½

Section 4—Room 12, back west entry

	Thickness Ft.	in.
Roof: "Slate"	..	..
Coal	1	1
Pyrite band	..	1½
Coal	..	11½
Pyrite and clay	..	2
Coal	2	..
Floor: Fire clay	..	..
	4	4

Character of the coal: The bed contains a fairly continuous band of "brown sulphur" about 18 inches to 2 feet from the top. Not uncommonly two such bands are present.

The horsebacks in this mine are very numerous. The mine map shows that the "fault" is encountered on the west side, trending about northeast-southwest from the S. W. cor. sec. 2, Hollis Township (T. 7 N., R. 7 E.). The same or another body of sandstone is also present at the usual horizon of the coal in section 11.

Character of the roof: The ordinary roof consisting of black shale, clod, and cap-rock is present except where the sandstone has cut down to the coal. The parting between the coal and the shale roof is poor and commonly the lower 4 to 6 inches of the roof comes down with the coal. It is rather difficult to separate the shale from the coal, so that the waste material thrown into the gob contains considerable coal.

MAPLETON COAL COMPANY'S NO. 1 MINE, AT MAPLETON

Entrance: Slope; No. 5 coal.

Thickness of coal: Uniform; varies between about 4 feet 4 inches and about 4 feet 10 inches; averages 4 feet 6 inches.

Section of the coal:

Section of No. 5 coal in the mine of the Mapleton Coal Company
Measured in a room off the main west back entry

	Thickness Ft.	in.
Coal with streak of pyrite in upper inch	2	6
Coal, dirty	..	1/16
Coal	1	2 11/16
Mother coal	..	¼
Coal	1	..
	4	9

Character of the coal: The coal is very uniform and clean. About the only impurities are a few "horsebacks" and a few discontinuous clay and mother-coal bands 1/16 of an inch thick or less. Because of the great regularity of the coal, no special description of the seam is necessary.

Character of the roof: The roof is constant in character. The succession consists of the usual black "slate," clod, and cap-rock. The first is 12 to 14 inches thick, the second 14 to 16 inches, and the last 2 to 6 inches, lying from 24 to 30 inches above the coal. Above the cap-rock is gray shale. Although in places the cap-rock is rather soft and shaly, generally it forms a solid roof. The black shale or "slate" roof carries a few niggerheads lying in the "slate" and coal.

Character of the floor: The floor is fire clay; it heaves some where damp and rolls up under horsebacks.

EAST MAPLETON COAL COMPANY'S "EAST" MINE, AT MAPLETON

Entrance: Drift; No. 5 coal.

Thickness of coal: Varies from 4 feet 6 inches to 5 feet 8 inches; averages 5 feet.

Character of coal: The coal is very irregular due to horsebacks and persistent pyrite bands. The coal runs nearly 12 inches thicker than in other mines and the irregularities in thickness are greater. The horsebacks, commonly 2 to 3 feet through, are present almost constantly in the face. The cracks running up into the roof cut it up like a mosaic. The floor below is offset along lines matching the cracks in the roof, giving a relief of 8 to 12 inches.

The sulphur bands consist largely of the "brown" laminated pyrite. An almost continuous streak, generally 1½-inch thick and in places 6 to 9 inches lies about 24 inches from the top. These impurities and irregularities make mining very expensive, as it is probable that about half the material taken out of the mine is rock waste.

The sandstone "fault" of the region is reported to lie a short distance north of the present workings of the mine.

NEWSAM BROTHERS' NO. 4 MINE, AT GLASFORD

Entrance: Shaft; 148 feet to the top of No. 5 coal.

Thickness of coal: Practically uniform; varies from 4 feet 4 inches to 4 feet 6 inches.

Character of the coal: The coal lies in a single bench with few irregularities. Horsebacks though present are not especially numerous. Some pyrite is encountered in streaks, balls, and lenses. Pyrite lenses averaging about 1 inch thick by 6 to 7 inches across are especially common near the horsebacks. They begin to appear 6 to 8 feet back from the fissure. Some of the horsebacks have a large per cent of pyrite in them and are very hard to mine.

Character of the roof: The roof consists of 6 to 14 inches of black "slate," 6 to 8 inches of clod, and 8 to 10 inches of limestone cap-rock. The parting between the coal and black shale is poor, due to the presence of pyrite balls and lenses at this position. The pyrite tends to bind the coal to the "slate" so that either the upper few inches of coal is left in the roof or else the lower part of the shale comes down with the coal. In the latter case the shale with 3 or 4 inches of attached coal is usually thrown into the gob.

Character of the floor: Fire clay, which is reported to heave when wet, forms the floor.

NO. 2 COAL

The coal which has been reopened during the last year in the mine at Pottstown, and the coal formerly mined by the Third Vein Coal

Company at Orchard Mines, and which is encountered in several drill holes in the county 117 to 140 feet below No. 5 coal, is believed to be the No. 2 bed.

The thickness of the coal averages about 2½ feet, or about two-thirds the thickness of No. 5 in this region and about 1 foot thinner than No. 2 coal in the La Salle and Spring Valley region. Here as elsewhere the coal is apparently regular in thickness, and uniform in character over large areas. Impurities that could seriously affect the value of the coal are lacking. The brassy nodules of pyrite typical of this coal are present, but because their contact with the coal is sharp and clean, they can be readily removed at the face. The pyrite impregnates the surrounding coal little if any, in contrast with the many pyrites lenses in other coals, and it is therefore generally unnecessary to discard much coal with the sulphur balls.

Roof conditions are normal for No. 2 coal. The "soapstone" or gray shale and black "slate" found in succession above the coal in the Longwall District[1] seems to be very widespread. The succession in this field seems to be the same as that in the northern district. The gray shale or "soapstone" is 9 to 12 feet thick on the average, which is a few feet thinner than at La Salle, and the black "slate" is about 2 feet thick. The "slate" carries large niggerheads or limestone concretions as in other regions. Above the black shale is a limestone about 2 feet in thickness. In places the black shale comes down on the coal cutting out the soapstone.

This coal is always mined by the longwall system, and except for the fact that the coal is thin, conditions are favorable for mining. There is little question but that eventually this bed will be extensively mined in this region, though probably not until the best areas of No. 5 coal are exhausted.

The chemical character of No. 2 coal is discussed briefly in Part I and an analysis of the bed is included in Table 3.

MINE NOTES, NO. 2 COAL

The following notes are based upon observations in two mines operating in No. 2 coal. Of these the Third Vein Coal Company has not been in operation for several years, the observations having been made in 1908.

THIRD VEIN COAL COMPANY'S ABANDONED MINE IN NW. ¼ SEC. 14, T. 7 N., R 7 E.

Entrance: Shaft; 162 feet to the top of No. 2 coal.

Thickness of coal: Varies from 2½ to 3½ feet; averages about 2 feet 11 inches.

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[1] Illinois Coal Mining Investigations Bull. 10, 1915.

Section of the coal: The coal was measured southwest of the shaft in room No. 5 off the first straight south (?) entry. The coal was 32 inches thick, with gray shale roof and fire-clay floor.

Character of the coal: The coal contained one sulphur lens which in the face measured 1 by 6 inches. Such lenses were reported to be rare and to occur at any place in the bed. The coal is described as "long grain."

Character of the roof: The shale or "soapstone" is a slabby dark-gray shale with small lenses of light-gray, sandy shale 1 inch thick. The gray shale is generally 8 to 12 feet thick, but is absent in places, the black "slate" resting on the coal. The "soapstone" is slabby, dark gray, and contains small 1-inch thick lenses of light-gray sandy shale. The black "slate" above is thin, shelly, hard, and brittle, with half-inch lumps on the bedding planes, and is reported to be about 10 feet thick. It contains niggerheads commonly as large as 12 by 6 by 24 inches.

Character of the floor: The floor is fire clay which is at least 6 feet thick. At one place it has been drilled into to a depth of 12 feet.

JOHN A. HOFFMAN'S "BLUE FLY" (WANTLING) MINE, AT POTTSTOWN

Entrance: Shaft; 107 feet to the top of No. 2 coal.

Thickness of coal: Varies from 2 feet 4 inches to 2 feet 8 inches; averages 2½ feet.

Sections of the coal:

SECTIONS OF NO. 2 COAL IN THE "BLUE FLY" MINE. AT POTTSTOWN

Section 1

	Thickness	
	Ft.	*in.*
Roof: Gray shale or "soapstone" containing small lime and pyrite concretions, 9 feet or more	..	..
Coal, clean	1	$9\frac{7}{16}$
Pyrite streak	..	$\frac{1}{16}$
Coal	..	3
Clay band	..	½
Coal	..	4
Floor: Fire clay	..	..
	2	5

Section 2—50 feet south of shaft

	Thickness	
	Ft.	*in.*
Roof: Gray shale	..	..
Coal, containing one sulphur ball 4 inches thick	2	6
Floor: Fire clay	..	..
	2	6

Section 3—End of southwest entry

	Thickness	
	Ft.	*in.*
Roof: Gray shale	..	..
Coal	2	6
Floor: Fire clay	..	..
	2	6

Character of the coal: The seam is practically uniform throughout the mine. The few partings are not persistent, but sulphur lenses and balls occur at various positions. Many seem to be pyritized parts of plants. These average in size about ¼ by 8 to 10 inches; some are as large as 4 by 12 to 14 inches. The amount of pyrite present is estimated to be between 1 and 2 per cent by weight of the coal.

The coal is rather hard and bright. Some cleat is developed, the fracture being north and south, and at right angles. Vertical sheets of pyrite are present but are not persistent in some of the joint cracks.

Character of the roof: The roof rock is typical "soapstone" about 9 feet thick. Above this is 2 feet of black "slate" which is capped in turn by a 2-foot limestone.

Character of the floor: The floor clay is a gray, even-textured clay which is reported to be 3 to 4 feet thick. Its character is not well known. It probably will heave if wet.

NO. 1 COAL

No. 1 coal has been worked in the mine at Pottstown at a depth of 240 feet, 133 feet below No. 2 coal. Udden[1] states that the lower bed consists of a lower bench varying in thicknes from 2 feet 2 inches to 3 feet, a parting of shale less than 3 feet thick, and an upper bench, 1 foot 2 inches to 1 foot 4 inches thick. Where the parting between the two benches was not too heavy, both were mined. The coal is of fairly good quality, but the mining was too expensive for the market at the time, and operations ceased more than ten years ago.

In general it is believed that this seam of coal is probably too thin to be of commercial importance for many years. It is possible, however, that there is beneath it a clay of commercial value, which if mined with the coal could be profitably extracted. Unfortunately, information in regard to the quality of the clay is not definite. Clays of commercial importance, however, are known to underlie the horizon of No. 1 coal in other parts of the State, especially in the counties west and south of Peoria County, so that exploration might be rewarded by discovery of similar clays in this county.

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[1] U. S. Geological Survey Bull. 506, p. 80.

SANGAMON COUNTY

Production and Mines

Production in tons from No. 5 and No. 6 coals, year ending June 30, 1920	6,844,049
Production in tons from No. 5 coal, year ending June 30, 1920	4,485,434
Average production from No. 5 and No. 6 coals, 1916-1920, inclusive	6,696,458
Average production from No. 5 coal, 1916-1920, inclusive	4,564,363
Total production, from No. 5 and No. 6 coals, 1881-1920	129,054,297
Total production from No. 5 coal, 1881-1920	85,000,000±

The total production of coal from Sangamon County for the year ending June 30, 1920, was a little more than 9 per cent of the State's entire output. The production of No. 5 coal in the county was about two-thirds of the combined production from No. 5 and No. 6 coal. Six shipping mines in the southern part of the county report a production of 2,358,615 tons of No. 6 coal; and 22 shipping and 4 wagon mines in the northern part of the county produced 4,485,434 tons of No. 5 coal. Sangamon County as a whole ranked fourth among the counties of the State. The shipping mines in operation in 1920 are listed in Table 6.

Coal Bearing Rocks

Information concerning the geological succession of the northern part of Sangamon, where No. 5 is the important coal mined, is contained in a report on the Springfield quadrangle by T. E. Savage[1], and in an earlier report on the geology and mineral resources of the Tallula and Springfield quadrangles by E. W. Shaw and T. E. Savage.[2]

These two publications will be largely drawn upon in describing the coal-bearing rocks and the character of the coals.

The record of a deep hole is included in Part I and used in Plate II.

The following extract from State Geological Survey Bulletin 20 describes particularly the rocks underlying the Springfield quadrangle but applies generally to all that part of the county covered by this report.

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[1] Savage, T. E., The Geology and mineral resources of the Springfield quadrangle: Illinois State Geological Survey Bull. 20 pp. 97-130, 1915.

[2] Shaw, E. W., and Savage, T. E., U. S. Geological Survey Geol. Atlas: Tullula-Springfield folio (No. 188) 1913.

KINDS OF ROCK IN THE AREA

"The rocks of the Springfield quadrangle consist of: (1) surficial materials, composed of unconsolidated beds of glacial till or drift, loess, sand, and alluvium which have been derived from the breaking down of pre-existing rocks; and (2) sedimentary rocks, which underlie the surficial materials and consist of more or less consolidated beds of sandstone, shale, limestone, and seams of coal, arranged in nearly horizontal layers.

SURFICIAL MATERIALS

"The surficial materials in this area comprise glacial, aeolian, and fluvial deposits, which cover the sedimentary rocks to an average depth of about 35 feet. They are thinnest over the areas that formed the highlands in the pre-glacial time and are thickest above the valleys of the early Pleistocene streams. Sangamon River follows such an old valley along its northward course near the west side of the quadrangle. Over this valley a well in the NW. 1/4 sec. 23, T. 18 N., R. 6 W. was put down 170 feet without reaching the bottom of the surficial materials. The altitude of the bottom of this drilling was 125 feet lower than the surface of the consolidated rocks two miles farther east.

INDURATED ROCKS

GENERAL DESCRIPTION

"The hard rocks of this region have been studied in natural exposures through a thickness of 225 feet. By means of test borings for coal and oil they have been explored to a depth of 1,500 feet. Columnar sections of the logs of representative coal shafts and test borings are given in Plate VII. These show in detail the character and sequence of the strata that underlie the surface materials as far as they have been explored in this region. All the information concerning the rocks underlying the Pennsylvanian strata in this area is obtained from a drilling near Springfield, a log of which is shown in section 1, Plate VII. The succession and geological position of these rocks are also shown in the following generalized section.

Generalized section of hard rocks known in the Springfield quadrangle

	Thickness *Feet*
Pennsylvanian system—	
McLeansboro formation—including all of the Pennsylvanian strata above the top of No. 6 coal, and composed of shales, sandstones, some impure limestones, and thin coals........	46–225
Carbondale formation—embracing all of the strata between the base of No. 2 coal and the top of No. 6 coal; and consisting of shales, sandstones, limestone, and productive coal beds; about	243
Pottsville formation—comprising the strata between the bottom of the Pennsylvanian and the base of No. 2 coal, and composed mostly of sandstones in the lower and shales in the upper part, with interbedded thin coals; about.........	278
Mississippian system—	
Salem and St. Louis formations—predominantly limestones with some shales; about................................	215
Keokuk and Warsaw formations—dominantly shales with some limestones; about	164
Burlington formation—cherty limestones and chert; about....	106
Kinderhook formation—greenish to bluish-gray shale, limestone and red shaly limestone; about....................	155
Devonian system—	
Upper Devonian series—dark shale with spores of *Sporangites* abundant; about	133
Middle Devonian series (Hamilton of Iowa or Northwest province)—gray limestone; to bottom of boring..........	28+

POTTSVILLE FORMATION

"Pottsville strata comprising the base of the Pennsylvanian system have been explored in three deep borings. They consist of coarse, gray sandstone and some conglomerate in the lower part, and shales or sandy shales predominating in the middle and upper portions. A thin coal bed lies 140 feet from the base and a somewhat thicker coal about 100 feet above the former and 33 feet below the bottom of No. 2 coal.

CARBONDALE FORMATION

"It has seemed desirable by the Survey to use the name Carbondale as a substitute for, and to make it embrace all the strata that were included in, both the Petersburg and the La Salle formations as described in a previous report.[1] This is the important coal-bearing formation in the State. Its basal member, No. 2 coal, consists usually of two thin beds separated by about 4 feet of dark shale. Above this coal is a shale which is followed by sandstone, and that succeeded by dark-colored shale up to an 18-inch coal bed, about 80 feet above coal No. 2. Between this coal and the next higher coal bed is an interval of about 55 feet, occupied almost exclusively by dark shale. Above this coal gray or blue to black shales extend to coal No. 5 which lies about 54 feet above the next lower coal.

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[1] De Wolf, F. W., Introduction to studies of Illinois coal: Illinois State Geological Survey Bulletin 16, p. 180, 1910.

"No. 5 (Springfield) coal is the important coal seam in this region and has an average thickness of about 6 feet. It contains numerous characteristic clay seams or 'horsebacks' which extend down into it, or through it, in a more or less vertical direction. The roof of this coal consists of 3 to 5 feet of black, laminated, fissile shale bearing numerous shells of *Orbiculoidea missouriensis* and other fossils, and containing in the lower part numerous rounded nodules ('niggerheads') of calcareous pyritic shale. A limestone cap rock, generally about 12 inches thick, overlies the black shale, and is followed by 1 to 4 feet of light-colored shale. No. 6 coal lies about 50 feet above No. 5 coal and, with the exception of No. 5 cap rock, the strata lying between these coals are mostly shale.

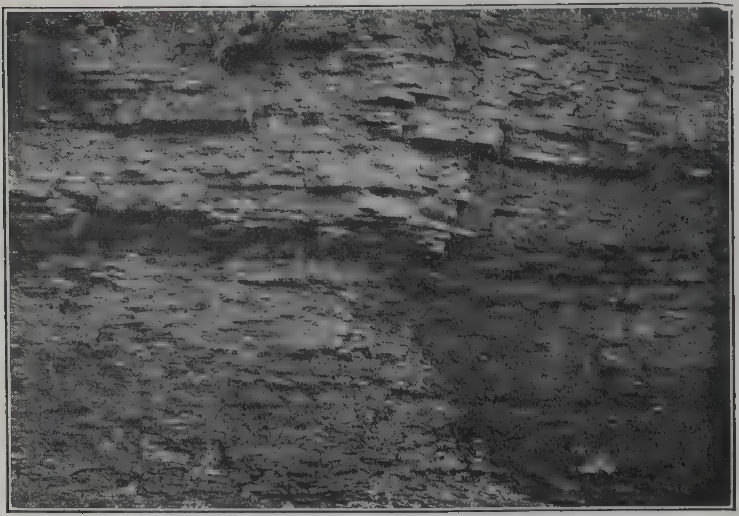

FIG. 26.—Photograph of a shale bed a short distance above No. 7 coal, exposed in the south bank of Spring Creek, NE. ¼ sec. 25, T. 16 N., R. 6 W.

"Within the quadrangle No. 6 coal is only 2 to 14 inches thick, but it becomes thicker and has been mined at Mechanicsburg to the east and at Chatham to the south, only a short distance from the borders of this area.

MCLEANSBORO FORMATION

"The roof shale of No. 6 coal, the basal member of the McLeansboro formation, is 3 to 5 feet thick. It is followed by about 6 feet of limestone which contains *Fusulina ventricosa* as the characteristic fossil. A thin coal (No. 7) 3 to 4 inches thick, occurs about 45 feet above the No. 6 bed. Between these coals are several feet of red, mottled shales which are exposed at Ralls Ford on Sangamon River, and constitute a very characteristic and easily recognized horizon throughout this region. The shale may, for convenience, be called the Ralls Ford shale member. Above No. 7 coal there follows a bed of bluish-gray shale with occasional sandy layers about 45 feet thick, exposed in the south bank of Spring Creek in the NE.¼ sec. 25, T. 16 N., R. 6 W., and shown in figure 26.

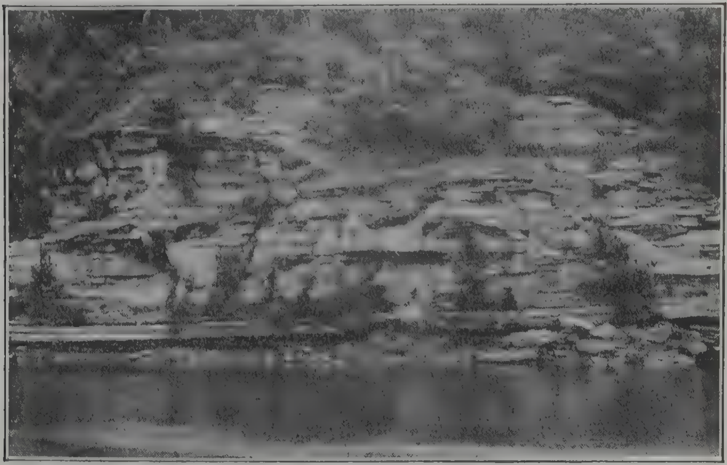

FIG. 27.—View of sandstone below No. 8 coal, exposed in the north bank of Sangamon River at Carpenter's bridge, NW. ¼ sec. 1, T. 16 N., R. 5 W.

"Over a very limited area near the extreme northwest corner of the quadrangle there outcrops along Indian Creek about 6 feet of hard, gray, partly brecciated limestone which is better exposed in the banks of Rock Creek a few miles west of Athens. This limestone is thought to correspond with the Lonsdale quarry limestone in the Peoria quadrangle. Over the greater portion of the Springfield area this limestone is wanting, but its place appears to be at the top of the shale bed above No. 7 coal.

"Above this shale are 30 or more feet of sandstone exposed in the north bank of Sangamon River at Carpenter's bridge, NW. ¼ sec. 1, T. 16 N., R. 5 W. (see figure 27). A few feet of shale separates this sandstone from No. 8 coal and associated beds.

"No. 8 coal, the underclay below, and the roof shale and cap rock above, comprise a succession of strata that are easily recognized in the logs of mine shafts and test borings in the central and eastern portions of the area. They outcrop in the west bank of Sugar Creek, sec. 13, T. 15 N., R 5 W.; in the south bank of the Sangamon River, sec. 6, T. 16 N., R. 4 W.; and in the east bank of Fancy Creek, sec. 13, T. N., R. 4 W.

"Above the limestone overlying No. 8 coal is 40 or 50 feet of shale exposed in the shale pit of the Springfield Paving Brick Co. near Springfield. This is followed by about 35 feet of sandstone which outcrops along Sangamon River near the middle of sec. 4, T. 15 N., R. 4 W., and in the south half of sec. 27, T. 16 N., R. 4 W.

"Belonging a few feet above this sandstone is the Crow's Mill limestone, exposed in the old quarry near Crow's Mill along Sugar Creek about 3 miles south of the quadrangle. This is a hard limestone, bearing large shells of *Productus, Spirifer,* and *Composita.* It occurs in heavy layers, large masses of which, more or less shifted by the ice sheets of the glacial period, are present in the area under discussion."[1]

STRUCTURE

The structure of that part of Sangamon County which is included within the Tallula and Springfield quadrangles has been determined with as great detail as possible and the lay of the rocks as determined by the altitude of No. 5 coal is shown by maps in the U. S. Geological Folio 188.[2]

The structure map of the county, Plate VIII, is relatively detailed for the area included within the Tallula and Springfield quadrangles; but the structure for the part of the county east of the quadrangles is based on very scattered data and estimated elevations, and accordingly is shown by dashed contour lines.

The following statement from the Tallula-Springfield folio summarizes the structure in that area. The description includes the adjacent southeast portion of Menard County.

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[1] Savage, T. E., The geology and mineral resources of the Springfield quadrangle: Illinois State Geological Survey Bull. 20, pp. 102-107, 1915.

[2] Shaw, E. W., and Savage, T. E., Geological Survey Geol. Atlas: Tallula-Springfield Folio (No. 188), 1913.

STRUCTURE OF THE TALLULA AND SPRINGFIELD QUADRANGLES

"As a rule the strata of the Tallula and Springfield quadrangles dip somewhat south of east at the rate of about 10 feet to the mile, but this general dip is modified by low folds and minor irregularities, most of which are too-ill defined to be described separately but which are shown on the maps by contours drawn at intervals of 25 feet on the base of the Springfield coal. These irregularities are the product of irregularities in the surface upon which each layer was deposited and of differential settling and warping since deposition. The prevalent eastward dip is, in part at least, the result of deformation. It carries the base of the Carbondale formation from a position about 200 feet below the surface at the western side of the area to one nearly 600 feet below the surface on the eastern side. This general dip is modified by a syncline just east of Tallula, by an anticline extending southwestward from Springfield, and by many minor irregularities. The syncline east of Tallula is steeper on its west side, as might be expected on account of the prevailing eastward dip. In the mine of the Tallula Coal Co. the dip is so steep that the mine cars on an eastward trip must be 'spragged' or otherwise held in check. However, even where steepest, the dip dos not exceed 60 feet to the mile. In the northeastern part of the area the predominant dip is eastward and is about 10 feet to the mile. In the southern part the general dip is southeastward but is modified by a syncline and anticline which enter the area near the middle of the southern side. The anticline extends northeastward as far as Springfield, whence it curves to the southeast, passing near the village of Keys. West of Springfield the strata in the flanks of the arch dip 15 feet to the mile, but east of Springfield they be progressively flatter on both sides of the axis, for the anticline plunges southeastward in conformity to the general dip.

"In some areas the Springfield coal is almost level throughout several square miles; in others it dips more than 20 feet to the mile. In some places its dip differs from the general slope or is even opposite to it. In most of the mines, however, it has almost no perceptible dip, and throughout a considerable area between Pleasant Plains and Salisbury the coal bed and the other strata seem to lie practically horizontal. In the southeast quarter of the Tallula quadrangle the beds so far as is known dip regularly southeastward at the rate of about 15 feet to the mile, but in that district few borings have reached the coal and some of the structural features may have not yet been brought to light. Indeed, throughout a considerable part of this quadrangle no borings have reached recognizable strata, and the structure map therefore lacks many details which can be shown when the coal has been worked more extensively, but the mine shafts and borings already sunk are rather uniformly distributed, so that the major structural features as shown are believed to be approximately correct."[1]

Coals

COALS BELOW NO. 5

"A fairly persistent coal bed about 2½ feet thick lies about 58 feet below No. 5 coal. Another bed, which seems persistent, occurs about 120 feet below No. 5 coal, and averages about 2 feet in thickness. Two other coal beds which are locally present, aggregating about 3 feet in thickness and separated by a few feet of shale, lie at a depth of about 191 feet below No. 5 coal. In the Riverton section a 32-inch coal was reported 250 feet below the No. 5 bed, but in the Springfield boring the corresponding coal is much thinner. A few other thin bands occur locally in the Pennsylvanian strata below No. 5 coal. At some future time one or more of these lower coals may be of economic importance, but until the No. 5 bed becomes practically exhausted, the deeper and thinner coals will not be exploited.

No. 5 Coal

CHARACTERISTICS OF NO. 5 COAL

"The coal known as No. 5 (Springfield) is the only bed at present worked in the quadrangle. Its thickness varies but little in the different mines, the range within the area being from 5½ to 6⅔ feet. It lies entirely below drainage, being found at depths from 150 to 273 feet below the surface. The depth to the coal at any one place depends both upon the altitude of the surface and the altitude of the coal at that place. No. 5 coal is remarkably uniform and persistent, being found at every place where borings have been put down to its level, and it is also present in the State over an extensive territory to the west and south of the area.

CLAY SEAMS IN NO. 5 COAL

"One of the conspicuous features of No. 5 (Springfield) coal is the occurrence in it of numerous "horsebacks," as they are called by the miners. These are more or less irregular and branching fissures filled with clay or shale, extending downward from the overlying beds into or through the coal. They range in width from 2 of 3 inches to 3 or 4 feet, the walls not being very nearly parallel, and are considerably and abruptly wider in the coal than in the overlying roof shale. (See fig. 28.)

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[1] Op. cit.

"The clay or shale filling the fissures is light gray and generally soft. Rarely it is hard enough to emit sparks when struck with a hammer, but as a rule it soon slakes down into an incoherent mass on exposure to the air. The clay in many fissures contains fragments of black shale derived from the roof of the coal, reaching down 29 inches below the top of the coal. A few fragments of limestone from the cap rock are also found in this clay below the top of the coal bed. In horsebacks that cut through the coal bed pieces of coal have been found as much as 9 inches below the bottom of the bed. No fragments of coal have been found higher than the top of the coal bed.

"The fissures show no regularity of spacing or of direction. In some mines they are 40 to 60 feet apart; in others they are separated by 200 to 400 feet or more. They trend in various directions, no one direction predominating, even in the same mine. All are either vertical or steeply inclined, with irregular walls which gradually converge downward within the coal. They have a very slight vertical range. In the Mechanisburg mine a coal bed, formerly worked, lies about 35 feet above No. 5 coal, which is the coal now mined. Although No. 5 coal is cut by numerous horsebacks, none were encountered in the higher bed.

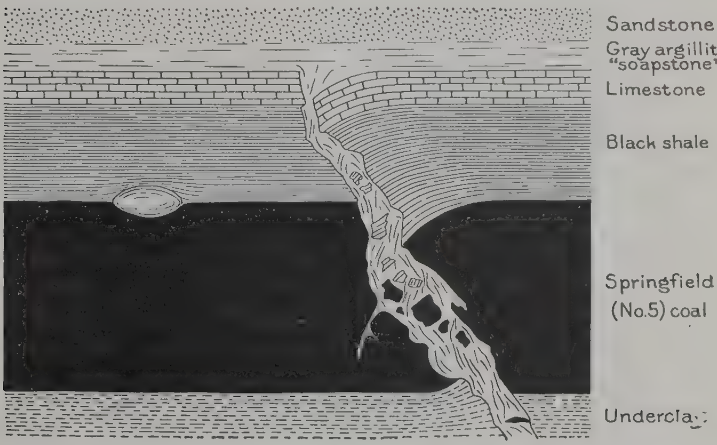

FIG. 28.—Sketch of typical clay seam or "horseback" seen in the Springfield Coal Mining Company's No. 5 mine, near Springfield.

"The walls of the fissures are slickensided but show no traces of weathering. Slickensided planes are also common in the clay filling the fissures. If the fissure is inclined, the uppermost laminae of the coal adjacent to the fissure on the overhanging side are bent somewhat steeply downward, the distortion fading out laterally within a few feet from the fissure, and in a few places the lowermost laminae of the coal on the other side of the fissure are bent upward, but to a much less degree. If the fissure is vertical, or nearly vertical, the uppermost laminae of the coal are bent downward on both sides of the fissure, but the more nearly vertical the fissure the less the amount of bending. In no fissure is there a true fault or a relative displacement of the middle part of the coal bed on the opposite sides of the fissure.

"The material filling the fissures appears to have been derived chiefly from the gray shale overlying the cap rock of the coal bed and to have been forced downward into the coal through breaks in the cap rock, as is indicated by the downward bending of the edges of the cap rock and of the coal laminae, by the occurrence of the fragments of the cap rock below the top of the coal, and by the continuity of the material of the fissures with that of the bed of gray shale.

"The coal appears to have yielded readily in a lateral direction, as shown by the greater width of the fissures in the coal bed than in the overlying and underlying strata. That the coal afforded accommodation to the strains causing the fissures is also indicated by the fact that many of the smaller fissures divide within the coal bed into branches which eventually die out in the coal.

"*Origin of Clay Seams.*—The formation of the clay-filled fissures in the Springfield coal was probably determined in part by the character of the overlying strata and in part, possibly, by the character of the underclay, which is dry and does not creep readily. The fissures were formed after the coal bed had been compressed nearly to its present volume, as is shown by the fact that the clay seams are not so deformed as they would be if the coal had been greatly compressed after they were developed. In some places clay from the fissures has penetrated joints in the adjacent coal, indicating that joints had been developed in the coal prior to the formation of the clay seams. Campbell[1] suggests that the carbonization of the coal beyond the lignitic condition depends on the presence of joints and cleavage planes along which gases may escape. If so, the bed should have undergone considerable compression and contraction after the joints were formed before it became bituminous.

"It is assumed that as the mass was slowly transformed into coal the contraction in its different parts was somewhat unequal, owing to its lack of homogeneity, and that the contraction continued long after the coal had been greatly consolidated. As long as the material possesses some degree of mobility the unequal shrinkage in the different parts of the bed was equalized by the movement of some of the mass toward points of least resistance. When the consolidation reached a certain stage such adjustment was no longer possible, so that continued unequal shrinkage of the mass produced unequal strains in the roof of the coal under its load of superposed rocks. Where the roof of the coal bed was a somewhat plastic shale the mobility of the particles of the shale permitted an adjustment of the inequalities of strain, resulting from the unequal contraction of the coal bed, the adjustment being accomplished by the formation of rock rolls such as are common at the top of the No. 6 (Herrin) coal in the Carterville-Zeigler region of southern Illinois. The roof shale in the vicinity of the rolls is cut by slickensided zones for several feet from the center of the roll, indicating a considerable lateral movement in the shale during the adjustment necessitated by the strains. The roof of the Springfield coal, however, is a hard, brittle shale without the mobility requisite for such adjustment. If the limestone cap rock had been very thick it might have withstood, without fracture, the strain due to unequal contraction in the underlying coal, but its average thickness is only 12 or 14 inches. The roof shale and the cap rock were together not strong enough to withstand the unequal strains to which they were subjected and broke under the pressure, at places marked by fissures.

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[1] Campbell, M. R., Econ. Geology, Vol. I, No. 1, p. 30, 1905.

"Immediately above the cap rock is a bed of rather soft gray shale, the material of which was squeezed downward through the fissures into the coal until the inequalities of pressure were adjusted. The adjustment was limited to a narrow zone below the fractures in the roof shale and cap rock, and its effects are of slight horizontal extent but penetrate to considerable depths.

CONCRETIONS ABOVE NO. 5 COAL

"Rounded concretions of calcareous, pyritic shale, called pyrite balls or 'niggerheads' and varying in size from one inch to four feet or more in diameter, are in places numerous along the contact zone of the black shale with the top of the coal. These concretions have been compressed less than either the overlying black shale or the underlying coal, and hence the laminæ of the black shale arch upward over the 'niggerheads,' and those of the upper part of the coal bend downward beneath them. The continued contraction of the coal seam, after the partial consolidation of the coal and of the overlying black shale, permitted a sufficient amount of movement to take place around and above the 'niggerheads' to give their surface a slickensided appearance, and to cause them to fall readily from their matrix after the underlying coal has been removed.

NO. 6 COAL

"No. 6 (Belleville or Herrin) coal is known only from the records of mine shafts and test borings, and as far as known is too thin to be profitably worked within this area. This bed was formerly mined at Mechanicsburg some distance east of Springfield and it is mined extensively 20 miles south. The coal where first penetrated by the Mechanicsburg shaft was about 6 feet in thickness, but it thinned rapidly northward, and was abandoned when No. 5 coal was discovered below it. In two of the shaft sections it was reported absent, but in these the horizon was marked by a black shale underlain by fire clay. This coal lies at an average distance of 49 feet above No. 5 coal, the distance increasing in general toward the north.

"In this quadrangle No. 6 coal varies in thickness between 2 and 14 inches, the average being 4½ inches. The thickness increases rapidly in a southerly direction. Near Waverly it is 3½ feet thick. At Chatham the thickness is between 5 and 6 feet, and at Divernon it is nearly 8 feet thick. This coal is mined extensively in the southern portion of Sangamon County, and farther south in the vicinity of Belleville, Duquoin, Carterville, and Herrin.

NO. 7 COAL

"No. 7 coal is not thick enough to be of economic importance, measuring generally only 2 or 3 inches. In three of the shaft records the horizon is known only by the associated fire clay and black shale strata, the coal itself not being present. The position of this coal is 50 feet above No. 6 coal, and about 100 feet above No. 5 coal.

NO. 8 COAL

"The thickness of No. 8 coal varies from 18 to 31 inches. The bed lies above drainage over the whole of the area except in a belt around 3 miles wide along the east border, and it has been eroded away from a strip of about equal width along the west side of the quadrangle. For several years before the deeper and thicker bed, No. 5, was discovered, this was the only coal worked in the Springfield region. The mining was done by drifts run into the hillsides at points where the bed outcropped above the level of the streams. Traces of such workings may be seen along a branch in W. ½ sec. 32, T. 16 N., R. 5 W.; along the west bank of Sugar Creek in sec. 12, T. 15 N., R. 5 W.; and they are numerous along the south bank of Sangamon River in sec. 5 and 6 T. 16 N., R. 4 W. The greatest measured thickness of this coal was at the Sangamon River localities where it reached

TABLE 7.—*Thickness of the several coal beds in the Springfield and Tallula quadrangles and the distance between them in mine shafts and borings* [a]

Name of mine	Thickness of coal No. 5	Distance between coals No. 5 and No. 6	Thickness of coal No. 6	Distance between coals No. 6 and No. 7	Thickness of coal No. 7	Distance between coals No. 7 and No. 8	Thickness of coal No. 8	Total distance from top of coal No. 5 to base of coal No. 8
	Inches	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*
Riverton Mine No. 1	72	43½	5	39	2	93	24	175
Barclay Coal Mining Co.	73	63	2	48½	?	89½	8	201
Williamsville Coal Co.	68	60	6	52	0	65½	18	179½
Test hole Springfield Colliery Co.	68	43½	0	62	0	54	?	160½
Springfield Colliery Co.	70	43	14	45½	3	76¾	24	169
Escape shaft Capitol Coal Co.	72	48½	0	56	0	58	24	164½
Spring Creek Coal Co.	72	41½	4	48½	2	79+	?	172
Boring ½ mi. SW. of Springfield	76	39	6	43	2	97	18	179½
Total averages	71	48	6	50	2	77	19½	175

[a] Reprinted from Ill. State Geol. Survey Bull. 20, p. 121.

31 inches. No. 8 coal lies at an average distance of about 77 feet above No. 7 coal, and about 175 feet above No. 5 coal.

"No swamp conditions or soil beds seem to have been developed in the interval between No. 5 and No. 6 coals. Between coal beds No. 6 and No. 7 there is generally reported one, and in some instances two, layers of black shale with underclays. In a few places there is a thin bed of coal at one of these levels. Between No. 7 and No. 8 coals there is less frequently reported a clay shale succession with a rare occurrence of a thin coal bed.

"A comparison of the thicknesses of the coal beds from No. 5 to No. 8, inclusive, and of the distances separating them in various mine shafts and borings is given in Table 7."[1]

MINE NOTES

DAWSON COAL MINING COMPANY'S MINE, AT DAWSON

Entrance: Shaft, about 250 feet to No. 5 coal.

Thickness of coal: Average thickness, 5 feet 2 inches.

Character of the coal: The upper foot and the lower foot of the seam are free from pyrite but there are small discontinuous lenses in the middle part. "Horsebacks" and niggerheads are fairly numerous. Some of the "horsebacks" contain much pyrite and are very hard. The coal has a general dip to the east which is interrupted by small rolls or arches, the dimensions of which were not reported.

Character of the roof: The roof is black "slate," 1 to 4 feet thick, and commonly underlies a cap-rock which attains a known thickness of 4 feet and which in turn underlies soapstone 1 to 20 feet thick.

Character of the floor: The underclay is 1½ to 5 feet thick. It is reported to heave.

BARCLAY COAL COMPANY'S ABANDONED MINE, AT BARCLAY

Entrance: Shaft; depth to No. 5 coal about 247 feet.

Thickness of coal: Averages about 5 feet 10 inches.

Character of the roof: The immediate roof is black slate about 3 feet thick, underlying a sandstone cap-rock 2 feet in thickness. The roof is reported to be good.

SANGAMON COAL COMPANY'S NO. 3 MINE, AT CANTRALL

Entrance: Shaft, 206 feet to the top of No. 5 coal.

Thickness of coal: Averages 5½ feet in thickness, with a maximum of over 6 feet.

Character of the coal: The coal is uniform in character and contains thin streaks of pyrite and some pyrite nodules as the principal impurities. These occur in no great abundance. The coal is mostly bright and finely laminated. Clay veins or "horsebacks" are the only important interruption in the continuity of the bed.

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[1] Savage, T. E., Geology and mineral resources of the Springfield quadrangle: Ill. State Geological Survey Bull. 20, pp. 115-120, 1913.

Character of the roof: The immediate roof is commonly black "slate." Locally the "slate" is absent and the cap-rock rests upon the coal. The usual thickness of the limestone cap-rock is about 1 foot, and the "slate" varies up to about 4 feet. Commonly a streak of pyrite occurs in the shale just above the coal, which "freezes" the coal to the shale so that in mining about 1 inch of the coal stays up. This is said to be desirable, as it protects the shale from the air. The slate also contains "niggerheads" which make the roof rather irregular.

Character of the floor: The underclay is about 3 feet thick. It heaves somewhat when wet.

CITIZENS COAL MINING COMPANY'S MINE "A," ½ MILE WEST OF SPRINGFIELD

Entrance: Shaft, 207 feet to No. 5 coal.

Thickness of coal: Where measured the coal had a thickness of 5 feet 4 inches.

Character of the roof: The immediate roof in the mine is black "slate," 1½ to 5 feet thick, but averaging 3½ feet. The cap-rock is a nodular limestone 12 to 14 inches thick; it is followed above by bluish-gray shale about 15 feet thick. Between the coal and black "slate" is commonly a band of pyrite with many fossils. "Niggerheads" are present in the black shale and "horsebacks" cut through the coal.

PEERLESS COAL COMPANY'S MINE, AT SPRINGFIELD

Entrance: Shaft; 223 feet to top of No. 5 coal.

Thickness of coal: Varies from 5 feet to 6 feet 2 inches.

Sections of the coal:

Sections of No. 5 coal in Peerless mine, Peerless Coal Company

Section 1—Room 18, 1st A east entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, fairly clean	2	7
Pyrite parting	..	..
Coal, fairly clean	3	4
Floor: Fire clay	..	..
	5	11

Section 2—Room 1 off 4B south off east entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Pyrite	..	1
Coal, fairly clean, dull	2	3
Pyrite parting	..	..
Coal, dirty, streaked with pyrite	3	5
Floor: Dark underclay	..	..
	5	9

Section 3—Room 11, 1st C west entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, fairly clean	5	10
Floor: Underclay	..	..
	5	10

Character of the coal: The coal is rather hard, bright, hackly, banded, and contains a small amount of pyrite in plates along joint cracks and in lenses parallel to the bedding. Although the bed is uniform in appearance throughout, it is somewhat harder at the bottom and the bottom coal is slightly "bony" in places. The clay veins or "horsebacks," which are rather common, vary in width up to more than 3 feet.

Character of the roof: The immediate roof is black shale about 3 feet thick, and the cap-rock is limestone 2 inches to 2 feet thick, averaging 1½ feet. The black sheety shale of the roof contains "niggerheads'' of all sizes up to several feet in diameter, which in most cases project from the roof down into the coal, and around which the coal is always bent. Between the coal and the black shale there is generally an inch or so of black shale and coal, representing a gradation from the coal to the "slate" above. Locally, however, the parting between the coal and the "slate" is sharp.

Character of the floor: The underclay is a dark-gray clay, 6 feet thick at the sump, which heaves when wet.

MECHANICSBURG COAL COMPANY'S MINE (NOT OPERATING), AT MECHANICSBURG

Entrance: Shaft; 300 feet to the top of No. 5 coal.

Thickness of the coal: Average thickness 5 feet.

Character of the coal: The coal is uniform in character from top to bottom with no persistent partings or bands. There is some gypsum along the vertical joint cracks. The coal is finely laminated with more mother coal than is commonly found in the mines near Springfield.

Character of the roof: The roof shale or "slate" is 1½ to 1 foot 10 inches thick, and the cap-rock above, where it is present, is limestone varying up to 1 foot in thickness.

Notes on No. 6 coal: About 27 feet above the bed being operated at the time the above observations were made (1912) is the bed thought to be No. 6 coal which was worked two years before. This upper bed has a 4- to 5-inch blue band near the middle. It is about 5 feet thick and at the shaft lies at a depth of 277 feet. To the west it is higher and is only 2½ feet thick. East of the shaft it becomes 6 feet thick at a distance of 140 feet, dipping 11 feet in the first 55 feet, after which it becomes level. At the air shaft, which is 346 feet north of the main shaft, the coal is 81 feet above its altitude at the hoisting shaft and is only 1 inch thick.

PEABODY COAL COMPANY'S MINE NO 6, AT SHERMAN

Entrance: Shaft; depth to No. 5 coal 198 feet.

Thickness of the coal: Average, 6 feet.

Character of the coal: The coal is laminated, free of dirt band, but contains considerable mineral charcoal. It shows a few pyrite bands as much as 1 inch thick, but these are not persistent. Thin plates of calcite or gypsum occupy the joint cracks. "Horsebacks" or clay slips are numerous. These are generally 2 to 4 inches across and extend various distances into the coal from the top, some cutting entirely across the seam. The filling of some of the horsebacks shows slickensided or smoothed surfaces, and cementation of the filling by calcite or possibly by pyrite is not uncommon.

Character of the floor: The underclay is hard and locally at least is "frozen" to the coal. Practically no bottom was taken up at the time the observations were made (1912).

SANGAMON COAL COMPANY'S MINE NO. 2, AT STEARNES (SPRINGFIELD)

Entrance: Shaft; 250 feet to the top of No. 5 coal.

Thickness of the coal: The coal averages almost 6 feet in thickness.

Sections of the coal:

Sections of No. 5 coal in mine No. 2, Sangamon Coal Company[1]

Section 1—Room 30, off south entry 21, one mile southeast of shaft

	Thickness	
	Ft.	*in.*
Roof: Shale	..	..
Coal	2	..
Mother coal	..	⅛
Coal	1	5
Shale	..	⅛
Coal	2	4
Floor: Fire clay	..	..
	5	9¼

Section 2—Entry 16 off stub entry 4, 4,000 feet northeast of shaft

	Thickness	
	Ft.	*in.*
Roof: Shale	..	..
Coal	1	3
Mother coal	..	⅛
Coal	1	5
Shale	..	¼
Coal	3	3
Floor: Underclay	..	..
	5	11⅜

Character of the coal: The coal is of the usual character for this district. Horsebacks are numerous, with a filling of hard white clay which is somewhat limy and carries small bits of coal. The coal is well jointed.

Character of roof: The roof is a limy shale, 1½ to 4½ feet thick, with a cap-rock 6 inches to 2 feet thick. The shale roof holds up well and is not generally taken down. It carries the usual "niggerheads" which form "pots" projecting down into the coal and which are smoothed or slickensided around their surfaces.

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[1] U. S. Bureau of Mines Bull. 22, p. 510.

Character of the floor: The floor is a hard gray underclay.

SANGAMON COUNTY MINING COMPANY'S JEFFERSON MINE, AT SPRINGFIELD

Entrance: Shaft; depth to the top of No. 5 coal about 240 feet.

Thickness of the coal: Varies from 3½ to 6½ feet, averaging 5 feet 9 inches.

Character of the coal: The "horseback" or clay veins are very numerous, so that they seriously interfere with mining operations. Many extend in a northwest-southeast direction; the miners, however, say that there is no predominant direction in which they run. The coal is commonly faulted down on one side of the "slips," the laminae being bent down on the downthrow side for a few feet back from the break. The similarity of the clay which fills the fissure to the soapstone above the cap-rock indicates that it apparently came from the soapstone through this latter bed. Pieces of the black roof shale are also common in the "clay veins," but no coal fragments are found in the clay above the top of the coal seam. The "horsebacks" commonly extend only part way through the coal, unless they are large. The fissure generally widens in the coal from a narrow opening in the cap-rock.

Character of the roof: The immediate roof is black laminated shale or "slate." At the bottom of the "slate" and extending up into the shale and down into the coal, are many large niggerheads, some of them large enough to extend across an entry. In places a band of ferruginous limestone, 2 to 6 inches thick, which carries numerous fossils, lies between the black shale and coal. This occupies the same position as the "niggerheads" and is composed of similar material.

Character of the floor: The coal is underlain by an underclay.

SPRINGFIELD DISTRICT COAL MINING COMPANY'S CORA OR NO. 51 MINE, AT ANDREW

Entrance: Shaft; 145 feet to No. 5 coal.

Thickness of coal: Average, 6 feet.

Roof and floor: Clay below coal, and 4 feet or more of limestone above.

SPRINGFIELD DISTRICT COAL MINING COMPANY'S MINE NO. 52, AT RIVERTON

Entrance: Shaft, depth to No. 5 coal 232 feet.

Thickness of coal: Varies from 5 feet 9 inches to 6 feet 2 inches; averages 5 feet 11 inches.

Sections of the coal:

Sections of the No. 5 coal in mine No. 52 of the Springfield District Coal Mining Company

Section 1—Room 2, off 2d north stub off 3d east north, 2,100 feet from the shaft

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, bright	2	..
Blackjack	..	1
Coal, bright	1	4
Pyrite streak	..	⅛
Coal, bright	1	..
Floor: Fire clay	..	..
	4	5⅛

Section 2—No. 6 room off 10th west off main south entry, 5,600 feet from the shaft

	Thickness	
	Ft.	*in.*
Roof: Black slate	..	..
Coal, bright	1	7
Pyrite streak	..	¼
Coal, bright	3	11
	5	6¼

Section 3—Back entry at face of main south entry, 5,700 feet from shaft

	Thickness	
	Ft.	*in.*
Coal, bright	1	..
Pyrite streak	..	½
Coal, bright	2	10
Pyrite	..	¼
Coal, bright	2	3
	6	1¾

Character of the coal: The coal has no unusual characteristics. The main cleat is southeast to northwest and the prevailing dip about 2½ per cent to the east.

Character of the roof and floor: The roof consists of black "slate" 2½ to 4 feet thick, cap-rock about 1 foot thick, and gray shale above the cap-rock. The floor is clay about 4 feet thick, resting upon 14 inches of hard rock below which is more shale.

SPRINGFIELD DISTRICT COAL MINING COMPANY'S MINE NO. 53 (WOODSIDE), AT SPRINGFIELD

Entrance: Shaft, about 245 feet to No. 5 coal.

Thickness of the coal: Varies from 4½ to 6¼ feet; averages 5 feet 10 inches.

Sections of the coal:

Sections of the No. 5 coal in mine No. 53 of the Springfield District Coal Mining Company

Section 1—Room 1 off the 9th west entry off the main south entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, clean, bright	..	3⅞
Mother coal	..	⅛
Coal, fairly clean	5	4
	5	8

Section 2—Room 5, off 8th south entry off southeast entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, fairly clean	2	6
Pyrite	..	⅛
Coal, bright, fairly clean	2	9⅞
	5	4

Section 3—Room 5, off 19th north entry off straight east entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, very hard, bright, clean	4	4¾
Bone and little pyrite	..	¼
Coal, hard, dull, clean	1	4
	5	9

Character of the coal: The coal is reported to lie in three benches; top bench about 1 foot thick, middle bench 3½ feet, and bottom bench 1½ feet. The coal has the usual laminated appearance due to dull and bright layers. Bedded impurities are inconspicuous. The chief irregularities in the coal are the clay veins ("horsebacks"). They vary in width, the maximum being about 6 feet, and consist of gray or white clay in which coal and limestone fragments are embedded.

Character of the roof and floor: The roof is black shale, 2 to 4 feet thick. The cap-rock when present varies in thickness, but is not more than 18 inches generally. The coal rests on underclay. It is reported that the clay beneath the horsebacks is harder and more pyritic than it is elsewhere.

SPRINGFIELD DISTRICT COAL MINING COMPANY'S MINE NO. 55, AT SPRINGFIELD

Entrance: Shaft; 250 feet to the top of No. 5 coal.

Thickness of the coal: Varies from 5 feet 9 inches to 6 feet 3 inches: averages 5 feet 11 inches.

Character of the coal: No unusual features noted. Horsebacks are common and these commonly show a downward bending of the coal laminae on the side of the downthrow. The downthrow of one clay vein amounted to 13½ inches, and of another, 15 inches. At a number of slips, a slight upward bending of the coal at the bottom of the bed opposite the downthrow side is evident. In general the more nearly vertical the "horseback," the less the displacement of the coal on either side.

Character of the roof and floor: The shale which forms the roof varies in thickness from 2½ to 4 feet. The limestone cap-rock present in some places is commonly 3 to 6 inches thick. Gray soapstone overlies the cap-rock. Locally a 2- to 10-inch bed of pyrite-bearing limestone containing numerous fossils lies between the black shale and the coal. The floor is underclay.

BISSELL COAL COMPANY'S MINE AT BISSELL [1]

Entrance: Shaft; about 235 feet to No. 5 coal.

Thickness of the coal: Two measurements of the coal in this mine show a thickness of 5 feet 9 inches and 6 feet 1½ inches, respectively.

Character of the coal: "Horsebacks" are common, and thin pyrite lenses are present in small amount in the middle of the bed.

Character of the roof: The roof is black shale 1½ to 4 feet thick, with locally a pyrite band ⅓ to 1 inch thick between the coal and the "slate." "Niggerheads" are not common. The cap-rock varies from 2 inches to 4 feet in thickness.

UNION FUEL COMPANY'S MINE NO. 2, AT KEYS

Entrance: Shaft; 220 feet to the top of No. 5 coal.

Thickness of the coal: Average thickness between 5½ and 5⅔ feet.

Character of the coal: The upper 2 feet of the bed is said to furnish the best coal; the next foot carries thin streaks of pyrite, and the lower coal is good. The main cleat is northeast-southwest, and the bed dips mainly to the southwest. On the extreme east, however, there is an eastward dip. The coal is cut by "horsebacks."

Character of the roof: The roof is black "slate,'' 1 foot 2 inches to 5 feet thick, with a cap-rock present in places and varying in thickness up to about 1 foot.

UNION FUEL COMPANY'S MINE NO. 5, AT SELBYTOWN

Entrance: Shaft; 267 feet to the top of No. 5 coal.

Thickness of the coal: Average, 5 feet 8 inches.

Character of the coal: The coal has a cleat which is directed near east and west. "Horsebacks" are not numerous.

Character of the roof and floor: The roof is black shale or "slate" with an average thickness of 3 feet but varying from 6 inches to 4½ feet. It is reported to make a good roof and to have but few "niggerheads." The limestone cap-rock is from 4 inches to 2 feet thick. The floor is fire clay 2½ feet or more in thickness, which heaves considerably.

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[1] Formerly Standard Washed Coal Company, Mine No. 2.

SCHUYLER COUNTY

Production and Mines

Mining operations in Schuyler County are all by nonshipping (or wagon) mines, and are confined to two beds, No. 2 and No. 5, of which probably No. 2 is the more important. During the year ending June 30, 1920, there were 28 local mines in the county which produced a total of 17,737 tons. Five of these, all in the vicinity of Rushville, produced between 1,000 and 4,200 tons, and according to the mining inspector's reports, it is only in this vicinity that No. 5 coal is worked in Schuyler County.

Coal-bearing Rocks

Schuyler County is included within the area of District III as well as IV and, because of the larger area underlain by the No. 2 coal, as compared with the area underlain by No. 5 coal, will be discussed in greater detail in the report on District III than in this report. No. 5 coal underlies only the uplands near Rushville, for the most part in T. 2 N., R. 1 W., and the eastern part of T. 2 N., R. 2 W. In all cases it is worked by shaft, slope, or drift, and so far as known it has never been stripped to any extent in this region, though there are possibly

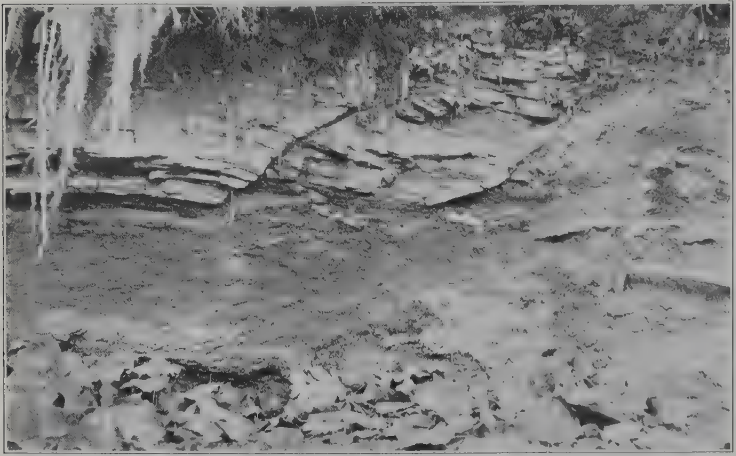

Fig. 29.—Photograph of No. 5 coal in outcrop northeast of Rushville, near the center of sec. 23, T. 2 N., R. 1 W.; the bed is cut by a small fault and a nearby "horseback."

areas where it is under too light a cover to permit use of any other method.

Between No. 5 and No. 2 coals, Worthen reports an interval of 175 to 200 feet northeast of Pleasant View. Of these strata possibly the most conspicuous is a heavy sandstone and sandy shale member which is well exposed along the Chicago, Burlington and Quincy Railroad between Rushville and Ray, beginning a few feet below No. 5 coal and having a thickness of about 100 feet.

Coals

NO. 5 COAL

The upper or No. 5 coal in Schuyler County, outcrops near Rushville, with a thickness of 4 to 6 feet, and has the usual black shale roof with "niggerheads" and limestone cap-rock, and is cut by "clay veins" or horsebacks. A photograph of one of these "horsebacks" as seen in an outcrop northeast of Rushville is reproduced as figure 29. So far as known the coal partakes of all its usual characteristics displayed in Fulton County.

NO. 2 COAL

No. 2 coal is widespread at a uniform thickness in Schuyler County except where it has been eroded along streams. A map presented in Bulletin 31 of the State Geological Survey[1] indicates a general southward dip of the coal from 580 near Littleton to 510 at Frederick and near Ripley. Assuming a constant interval between coals No. 2 and No. 5 over the county, the altitude of the upper coal should vary from about 750 to 680 feet from north to south. As the surface altitude in Schuyler County rarely exceeds 700 feet, and as the surface of bed rock is somewhat lower on account of the cover of glacial drift, it is obvious that the upper coal can be present only in the southern part of the county.

The dip is not regular to the south but is interrupted by local anticlines and synclines which bring the coal above or below the level that might be expected on the basis of a perfectly regular dip.

For a more detailed account of No. 2 coal in Schuyler County the reader must await a later bulletin on coal resources of District III.

NO. 1 COAL

No. 1 coal is known to have a local distribution in the eastern part of the county. It is not being worked, however, so far as is known. Whenever seen it was thin, 18 inches to 2 feet, and in one area in two beds, each about 2 feet in thickness. This coal as well as No. 2 will be described in greater detail in a later report.

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[1] Morse, W. C., and Kay, Fred H., The area south of the Colmar oil field: Illinois State Geological Survey Bull. 31, Plate I, 1914.

TAZEWELL COUNTY

PRODUCTION AND MINES

Production in tons, year ending June 30, 1920..............721,288
Average production 1916-1920, inclusive....................531,272

The production of coal from Tazewell County for the year ending June 30, 1920, was a little less than one per cent of the total production for the State and the county ranked twentieth. Six shipping mines and four local mines operated in that year. The names of the six shipping mines together with their production are given in Table 6.

SURFICIAL DEPOSITS

A large part of the surface of Tazewell County is morainic, and beneath the ridges of glacial material the drift is commonly thick. For instance, the preceding record of a drilling at Washington shows a depth to the rock of 335 feet 11 inches. It will be noted also that the unconsolidated material includes several water-bearing sandy horizons described as "quicksand." This record is probably representative of the more unfavorable conditions for exploration and development work that exist in the county, as it is not probable that a much greater thickness than 335 feet is generally present.

COAL-BEARING ROCKS

The coal bearing rocks of Tazewell County include strata of the Pennsylvanian system from the base up to some horizon above No. 7 coal but probably below the Lonsdale limestone. The youngest rocks in the county are adjacent to the Illinois from near Farm Creek to 5 or 6 miles south of Pekin. The slope of the rock surface is apparently eastward from this area, wherein it is at a relatively high altitude, and is sufficient so that the rock surface passes below the horizon of No. 5 coal. The rock surface also slopes to the north from this area wherein it is relatively high so that the surface of the rock passes below the bed of Farm Creek, the slope to the north accordingly being more abrupt than that to the east. It is probable that the rock surface in the northern part of the county is largely below the horizon of No. 5 coal. It appears, therefore, from the evidence at hand, that there is only a small area of rocks of the McLeansboro formation in the western part of the county, the greater part of the county being underlain by Pennsylvanian rocks belonging to the Carbondale and Pottsville formations.

Record of drilling in NE. cor. sec 23, T. 26 N., R. 3 W., near Washington, Illinois.

Altitude: Est. 745 feet.

Description of Strata	Thickness		Depth	
Quaternary system—				
Pleistocene and Recent—	*Ft.*	*in.*	*Ft.*	*in.*
Clay and loam	3	....	3	....
Gravel	83	....	86	....
Clay	24	....	110	....
Clay and gravel	20	....	130	....
Clay, light blue	15	....	145	....
Gravel	31	....	176	....
Clay	6	....	182	....
Gravel	7	....	189	....
Clay and gravel	10	....	199	....
Clay, light blue	8	....	207	....
Gravel	11	8	218	8
Sand	9	....	227	8
Quicksand	23	....	250	8
Gravel	7	....	257	8
Quicksand, gray	7	....	264	8
Quicksand, white	69	....	333	8
Gravel	2	3	335	11
Pennsylvanian system—				
Soapstone, light	25	....	360	11
Sandstone, light	15	....	375	11
"Slate," black	8	....	383	11
Coal	....	6	384	5
Fire clay	4	....	388	5
"Slate," light gray	26	....	414	5
"Slate," dark	17	6	431	11
"Slate," black	11	4	443	3
Coal (No. 2?)	3	8	446	11
Fire clay	3	....	449	11
"Slate"	8	9	458	8

Record of drilling about 6½ miles southeast of Pekin, Illinois.

Description of strata	Thickness *Feet*	Depth *Feet*
Quaternary system—		
Pleistocene and Recent—		
Clay, yellow	16	16
Clay, blue	140	156
Sand and gravel; some gas	10	166
Pennsylvanian system—		
Shale, dark	119	285
Fire clay	4	289
Shale, black	71	360
Shale, white	40	400
Shale, dark	20	420
Shale, white	45	465
Shale, dark	3	468
Coal (No. 2?)	4	472
Fire clay	9	481
Shale, white	34	515
Fire clay	4	519
Shale, white	84	603
Shale, dark	104	707
Sandstone	1	708
Shale, white	29	737
Sandstone	5	742
Limestone, blue	3	745
Sandstone	4	749
Limestone	2	751
Sandstone	3	754
Limestone	3	757

The operations in Tazewell County are all along or near the Illinois valley, where conditions are essentially the same as those described for Peoria County. The eastern part of the county is heavily drift covered, and rock exposures are very uncommon if they exist at all. So little drilling has been deep enough to penetrate the coal-bearing strata that except for a narrow strip between Pekin and East Peoria, the distribution and thickness of the coal beds is practically unknown in this county. There is little doubt, however, that No. 2 coal is widespread throughout the county in workable thickness, and probably No. 5 coal is also present in large areas.

Neither of these records gives sufficient detail to permit the accurate correlation of the coals. In one record the coal at a depth of 443 feet is considered as probably No. 2, since it is obviously too deep for No. 5. No. 2 coal lies about 150 feet below No. 5 in the Peoria region. The latter has an average altitude of 431 feet in Pekin Township. Thus No. 2 would have an altitude of about 290 feet. In the second record given above, the surface altitude is about 680 feet and that of the coal correlated as No. 2 is 208 feet. This is lower than the average altitude for the coal noted above, but the difference may be accounted for by the eastward dip of the rocks. The upper coal, No. 5, was apparently missed in drilling this hole, whereas in the hole near Washington it has apparently been eroded, the base of the drift lying below the horizon of the coal.

POTTSVILLE FORMATION

Concerning the character of the Pottsville formation in this county the only available information is that afforded by several water well records near Pekin and East Peoria, supplemented by data concerning the strata in the eastern part of Peoria County. It is unnecessary to repeat the description of the formation as given for Peoria County. It may be pointed out, however, that near Peoria in the Pottstown mine, one workable coal lies 110 to 130 feet below No. 2 coal. This coal lies in two benches separated by nearly 3 feet of shale, the upper bench 1 foot 3 inches and the lower bench 2 feet 3 inches in thickness. It is thought to be the No. 1 coal of the Illinois coal, which has been mined extensively in the Rock Island region and in the mine at Parrville, Fulton County. Although this coal is too thin to be mined profitably at present, it represents a valuable resource which must be drawn upon some day.

Between No. 1 and No. 2 coals there are possibly two coals of workable thickness, one 30 to 40 feet above No. 1 coal and the other about the same distance below No. 2 coal. The lower of these coals in some of the wells drilled in the Peoria district was reported to be about 30 inches in thickness, and the other between 1 and 2 feet. It is physically possible to mine coals 18 inches thick, with the proper equipment, at a cost not greatly exceeding the cost of mining the thinnest of the coals now mined in the State. Eventually after the supply of thicker coal has been exhausted, these thin beds will doubtless be worked.

CARBONDALE FORMATION

At the base of the Carbondale formation lies No. 2 coal, which is very probably widespread in this county, and has a thickness of about 3 feet. It is present at Pekin and East Peoria and at Washington, and in the surrounding counties, and lies nearly level throughout a large area east of the Illinois. There is only about 50 feet difference in the altitude of this coal at Pekin, at Bloomington, and at Washington. This coal commonly has a "soapstone" or gray shale roof up to about 20 feet in thickness with a 3-foot black paper-shale overlying the soapstone. The roof is especially adapted to the longwall method of mining which is employed in all cases where this seam is worked.

The details of the succession between this coal and No. 5 are not known. In surrounding counties the strata consist largely of shale with massive sandstone near the top of the section not uncommonly. The interval between these two coals in the Peoria region varies from 110 to 140 feet, and at Bloomington it is 130 feet, or essentially the same as at Peoria. It is not improbable, therefore, that the thicknesses and succession of strata are about the same in the intermediate region which includes Tazewell County. Details of the succession can be learned by reference to the chapters on McLean and Peoria counties.

No. 5 coal, which underlies at least the western part of the county in the vicinity of East Peoria and Pekin, and probably extends as far east as Groveland, varies in thickness from about 4 feet 4 inches at the north to about 4 feet 8 to 10 inches to the south. It has the usual characteristics of No. 5 coal; that is, it does not lie in benches, is characteristically cut by clay veins and by pyrite filled veins ("spars"), and contains banded brown or gray pyrite and a few bright pyrite balls in the upper part of the bed. Within the area of its outcrop along the bluff and beneath the drift it is fairly continuous, but in places is interrupted by "faults" which are interpreted as channel sandstone just as are the "faults" on the Peoria side of the river. Just northeast and south of its outcrop the coal is apt to be affected by preglacial or glacial erosion, so that considerable areas may not be minable. Development work in this county and in this coal bed should be preceded by careful exploration by the drill.

The strata overlying No. 5 coal vary from the usual black slate, clod cap-rock, and gray-shale succession to sandstone. Especially in Groveland Township sandstone is apparently at no place a great distance above the coal, and locally cuts down into the black shale and rests upon the coal. In the vicinity of Wesley the sandstone in places cuts out the coal entirely, just as it does in Hollis Township in Peoria County.

The section between No. 5 and No. 6 coals is composed largely of sandstone and sandy shale, the interval between the two coals being about 60 feet.

No. 6 coal in western Tazewell County is irregular in thickness. As shown by the following sections[1] it is in some places over 4 feet and in others less than 1½ feet.

---

[1] Udden, J. A., Geology and mineral resources of the Peoria quadrangle, Ill.: U. S. Geological Survey Bull. 506, pp. 45-46, 1912.

Section in the north bank of creek, one-fourth mile southwest of the NE. cor. sec. 24, Pekin Township

	Thickness	
	Ft.	*in.*
Shale, light gray	1	..
Limestone, thinning rapidly to east	2	..
Shale, "white top"	..	6
Coal, thinning rapidly to east (No. 6)	1	6
Fire clay	3	..
Shale, arenaceous	15	..
	23	..

Section in west bank of Lick Creek, near junction of its two forks, Sec. 25, Pekin Township

	Thickness	
	Ft.	*in.*
Sandstone	4	..
Sandstone, shaly	6	..
Limestone, discontinuous	1	..
Shale, "white top"	1	6
Coal, No. 6	2	6
Fire clay, with dark ferruginous band near middle	3	6
Shale, gray	2	6
Sandstone in somewhat shattered beds	3	..
Shale, light bluish-gray, arenaceous	23	..
	47	..

Section in west bank of Lick Creek, near wagon bridge, in NW. cor. Sec. 31, Groveland Township

	Thickness	
	Ft.	*in.*
Shale, light gray	6	..
Clay, structureless residuum firm	1	2
Shale, dark fissile, with gray discontinuous laminations	1	..
Coal	2	9
Clay	..	2
Coal, with lenses of pyrite near middle	1	6
Fire clay, greenish gray	4	..
	16	7

Careful drilling in the area underlain by No. 6 coal may discover areas in which the coal is as much as 4 feet thick. However, just as in southern Peoria County, this coal very commonly is overlain by a loose, incoherent, grayish shale called "white top" which is very hard to hold and which makes mining very expensive, and also cuts out a considerable proportion of the bed. The "white top" roof has been described in greater detail in the discussion of the coal resources of Peoria County.

MC LEANSBORO FORMATION

So far as known, the rocks of the McLeansboro formation are restricted in this county to a small area between Pekin and East Peoria. They include No. 7 coal, which has a thickness of 14 to 18 inches and lies about 30 to 35 feet above No. 6 coal.

The lower part of the formation which constitutes the roof of No. 6 coal is normally dark fissile shale, 1 to 3 feet thick, or gray shale called "white top." Commonly the black or gray shale is overlain by limestone cap-rock, 1 to 4 or 5 feet in thickness. Marly or calcareous shale overlies the limestone and grades upward into sandy shale or sandstone, which continues nearly to No. 7 coal. No. 7 coal is underlain by a few feet of underclay and shale.

The McLeansboro formation seems to have been eroded down to some horizon below the Lonsdale limestone, which lies near the top of the section on the west side of the river.

MINABLE COALS OF TAZEWELL COUNTY

The coals in Tazewell County which at present are of commercial importance are probably only No. 2 and No. 5, and of these only No. 5 is being worked. Very little is known about No. 2, but its persistence throughout the northern part of the State is a basis for inferring its presence in this area. No. 7 coal is apparently too thin to mine at present and No. 6 unsatisfactory because of its irregular character and poor roof. Any statement in regard to the occurrence and distribution of No. 1 coal and the possible existence of coals between No. 1 and No. 2 is pure speculation. It follows, therefore, that interest is mainly in No. 2 and No. 5 coals.

NO. 2 COAL

No. 2 coal is mined extensively in the Longwall District and is found in the northern and central portions of the Illinois coal field wherever shafts or bore holes have been sunk to its horizon. Commonly the seam is about 30 inches thick, with a good soapstone roof, which is excellently suited for Longwall methods of mining. As a rule it has no seriously detrimental impurities and is of slightly better quality than higher beds in the same locality. It is believed that this coal is generally present in this county, but it has never been worked.

NO. 5 COAL

There are several operations in No. 5 coal in Tazewell County along the bluff of the Illinois between East Peoria and Pekin. The coal has the same general characteristics as the seam in the Peoria district, described in the section on that county. The distribution of the coal is limited on the west by the Illinois valley, and in the other directions by pre-glacial or interglacial erosion. The rock surface slopes rather abruptly to the north at Farm Creek, so that it probably passes below the level of the coal; and although it slopes somewhat less abruptly to the east and south, still the grade is sufficient to cause the rock surface of the central and eastern parts of the county also to be probably largely below the horizon of No. 5 coal.

The coal in the East Peoria region is locally interrupted by sandstone "faults" especially in the vicinity of Wesley. These sandstone "faults" are thought by the writer to be the filling of channels cut into the peat deposit shortly after its deposition. In part of the area this same body of sandstone lies but a short distance above the coal, the base of it forming the roof of the coal in the places where the shale roof which is generally present has been eroded.

MINE NOTES

The following detailed description of conditions in a few of the Tazewell County mines will serve to set forth the general character of the coal and of the mining conditions in this area.

GROVELAND COAL MINING COMPANY'S MINE NO. 1, AT EAST PEORIA

Entrance: Shaft; depth to No. 5 coal, 85 feet.

Thickness of coal: Varies from 3 feet to 4 feet 8 inches; averages 4 feet 4 inches.

Sections of the coal:

Sections of No. 5 coal in Mine No. 1 of the Groveland Coal Mining Company

Section 1—Room 1 off 3d stub off the 6th east entry

	Thickness	
	Ft.	*in.*
Roof: Black fissile shale	..	..
Coal with thin streaks of clay and mother coal	4	3
Floor: Underclay	..	..
	4	3

Section 2—Room 6 off the 10th east entry

	Thickness	
	Ft.	*in.*
Coal	1	5
Pyrite (brown "sulphur")	..	1¾
Coal	2	10¼
	4	5

Character of the coal: The coal lies as a single bench without persistent partings. The thin bands of clay and mother coal, generally present in the face, are rarely more than ¼ inch in thickness, are not persistent at any one place, and not very important as impurities. On the east side of the mine pyrite bands of "brown sulphur" are commonly found near the horsebacks. These are generally about 1½ inches thick and may be 4 to 5 feet in length. They appear to be intimate interlaminations of pyrite and carbonaceous material.

The coal is practically uniform in thickness, the only departures from uniformity being near the "horsebacks" or clay slips. Where these fractures occur the coal is usually slightly displaced, the bed on one side of the fracture being somewhat lower than it is on the other (see fig. 30).

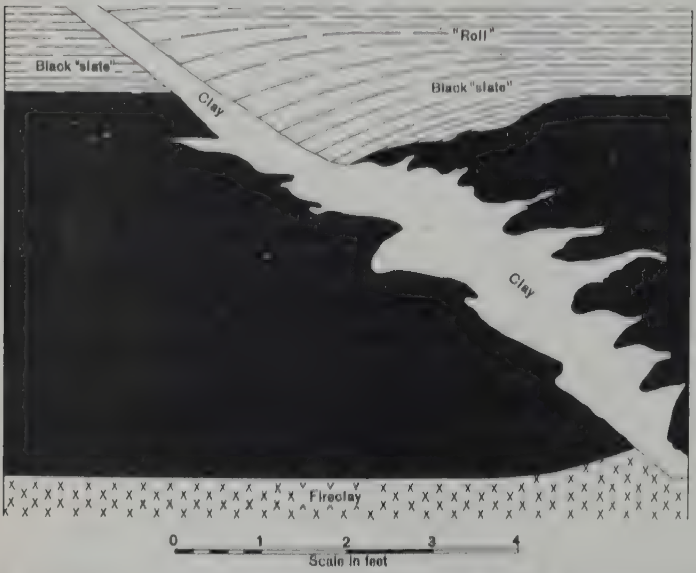

FIG 30.—Sketch of a "horseback" in No. 5 coal in the Groveland Coal Mining Company's No. 1 mine at East Peoria.

Commonly the fracture is at a fairly acute angle with the horizon of the bed, so that the roof on the downthrow side is much nearer the floor than under normal conditions. Similarly, the floor on the opposite side of the fracture is nearer the roof than usual. However, the floor does not commonly rise as high as the roof is down-faulted, there apparently being some compensation either in the coal or in the adjacent strata. These phenomena in the roof and floor are spoken of as "rolls."

The coal on the east side of the mine is badly fractured, but the fractures are not so generally filled with clay as they are elsewhere. Instead, pyrite-filled cracks, called "spar" by miners, are the common thing. Although rarely more than ¼ inch thick, they are very hard to drill so that the miners do not like to work in the part of the mine where they are common. Furthermore, there are cracks ("blind slips") which penetrate the coal and pass up into the roof but in a fresh face are not discernable, and which produce an extremely treacherous roof that is practically impossible to control.

Character of the roof: Incidental to the preceding description of the coal some mention has been made of certain difficulties encountered in the roof of this mine. Other characteristics may be mentioned.

The massive sandstone which lies a short distance above the coal throughout much of this area as well as the area south of Peoria on the west side of the Illinois, is exposed above the coal in a number of places in this mine. The sandstone has a very irregular base and accordingly lies at various heights above the coal, in places very close to the bed or even resting on it. Apparently there are no places where the sandstone cuts out the coal, though this condition is reported to have existed in an old mine a short distance to the north.

The usual roof is black shale, 8 to 14 inches thick, with clod and limestone above. The lower 2 inches of black shale or "slate" is called "draw slate." This is commonly "frozen" to the coal. The break that takes place in mining near the top of the bed commonly occurs an inch or two below the slate. If the break occurs in the slate so that the "draw slate" parts from the overlying shale, the material that is left lacks coherence and is difficult to keep. In this mine when the "draw slate" comes down it is soon followed by all the rest of the material up to the sandstone. In some localities in the mine this means as much as 20 feet of material.

The so-called cap-rock is a layer of fossiliferous gray limestone 2 to 8 inches thick which in places is hard but more commonly is shaly, with no supporting strength. The clod lying between the black shale and the "cap-rock" is a massive, dark gray, loosely coherent shale, about 14 inches thick, that falls readily. Overlying the cap-rock is a gray shale which continues up to the sandstone a distance of about 18 feet or less.

Character of the floor: The floor is underclay. No unusual characteristics other than the rolls associated with the horsebacks were noted.

JOHNSTON CITY BIG MUDDY COAL AND MINING COMPANY'S NO. 3 MINE, AT PEKIN.

Entrance: Shaft; depth to the top of No. 5 coal 205 feet.

Thickness of coal: Reported to average 4 feet 8 inches.

Character of the coal: The following description is based upon information obtained from the mine manager. The coal has not been seen by a Survey member.

The coal lies in a single bed, without benches. The few discontinuous bands of "sulphur" near the horsebacks and the little hard pyrite balls and lenses, are said to be too infrequent to seriously damage the coal. Horsebacks are fairly numerous and their removal entails considerable waste.

Character of the roof: The roof succession consists of 6 to 12 inches of black shale, called "slate," which sticks to the coal so that presumably either a few inches of coal is left in the roof or some of the shale comes down with the coal. Above the black shale is about 12 inches of clod, above which there is commonly 6 to 8 inches of limestone. This, however, is locally absent. A thick bed of shale overlies the limestone.

Character of the floor: Underclay about 18 inches thick. Below the clay is 12 inches of limestone which in turn is underlain by more clay.

The general characteristics of the coal in this mine are probably very similar to those of the coal in the Tazewell Coal Company's mine which is operated on an adjacent property.

TAZEWELL COAL COMPANY'S MINE NO. 1, AT PEKIN

Entrance: Shaft; 162 feet to the top of No. 5 coal.

Thickness of coal: Varies from about 4 feet to about 4 feet 10 inches; averages 4 feet 8 inches.

Sections of the coal:

Sections of No. 5 coal in mine of the Tazewell Coal Company

Section 1—Face of second entry off main south

	Thickness	
	Ft.	*in.*
Roof: Black slate	..	..
Coal, fairly clean	1	5¾
Pyrite	..	¼
Coal, clean and bright	1	11½
Bone	..	½
Coal, fairly clean	..	9
	4	3

Section 2—Face of room 5, 1st stub, 12th east off south entry

	Thickness	
	Ft.	*in.*
Roof: Black shale	..	..
Coal, left up	..	3 to 4
Coal, clean	..	1¼
Mother coal and pyrite	..	¼
Coal, very dirty	4	1
Floor: Underclay	..	..
	4	6

Section 3—Face of room 16, first stub east, 8th south off east entry

	Thickness	
	Ft.	*in.*
Roof: Black slate	..	..
Coal, slean, bright	1	2½
Pyrite lens	..	2½
Coal, clean, bright	..	8
Mother coal, soft	..	½
Coal, fairly clean and bright	2	3½
Floor: Underclay	..	..
	4	5

Character of the coal: The coal lies in a single bed with no benches, but contains discontinuous streaks of clay and mother coal, and near the horsebacks or clay slips lenses of pyrite are common. There is some calcite along the joints faces. "Horsebacks" are numerous and commonly so impregnated with pyrite that they are very hard. Fig. 31 is a reproduction of a sketch of a horseback. It will be observed that the clay vein plays out in the overlying shale into a number of cracks and that the underclay has been squeezed a short distance upward into the fracture. At the veins the cap-rock commonly shows a slight displacement. The side of the fracture in the coal is generally irregular, but also commonly shows "smooths" or slickensides.

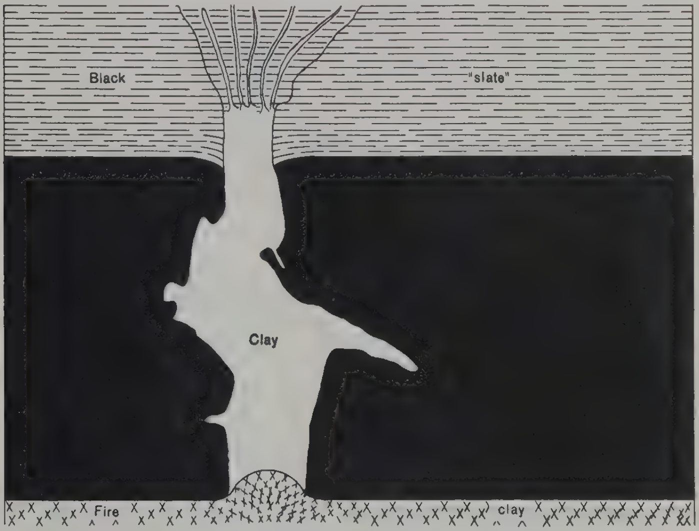

FIG. 31.—Sketch of a "horseback" in No. 5 coal in the Tazewell Coal Company's No. 1 mine at Pekin.

Character of the roof: The immediate roof is dark shale or "slate," 8 to 12 inches thick, which commonly sticks to the coal, so that either the upper 2 or 3 inches of coal is left up or the lower 2 or 3 inches or more of the shale comes away with the coal. This makes no particular difficulty. About 12 inches of clod lies between the black shale and the cap-rock. The latter is a limestone which is solid only locally and then is about 8 inches thick.

Character of the floor: The underclay is about 12 inches thick. It becomes hard 12 inches below the coal, but the upper part heaves badly in the air, and especially when it is wet.

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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
FRANK W. DE WOLF, Chief

Cooperative Mining Series

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ANALYSES OF ILLINOIS COALS

COMPILED BY

G. W. HAWLEY

ILLINOIS MINING INVESTIGATIONS

Prepared under a cooperative agreement between the Illinois State Geological Survey Division, the Engineering Experiment Station of the University of Illinois, and the U. S. Bureau of Mines

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ANALYSES OF ILLINOIS COALS

Compiled by G. W. Hawley

INTRODUCTION

A study of the chemical character of Illinois coals based on new face samples collected in 1921 from approximately 100 mines in various parts of the State was begun with a view to extending our knowledge of the chemical properties, heating quality, and special adaptability of all Illinois coals. A bulletin will be issued at an early date which will present the conclusions based on these data, but it seems desirable to publish the analytical data prior to the complete report. The analyses have been combined with data previously published by the State Geological Survey[1] [2] and also by the United States Bureau of Mines. References to the bulletins in which the analytical results of coal samples collected by the United States Bureau of Mines have been published, are indicated throughout the tables of analyses in order that the detailed descriptions of the samples may be consulted.

ANALYTICAL DATA

Analyses of Mine Samples

Table 1, which gives an alphabetical list of counties including the district classification (see fig. 1) and the coal beds for each county, serves as a cross reference.

The complete analyses of mine samples grouped by coal beds, under which the counties represented are arranged alphabetically, are given in Table 2. Analyses having the same index number are of samples for a single mine. Obviously, not as much dependence can be placed on a single analysis from a given mine as may be placed on a group from one mine. Two sets of values are given for each sample—one including the normal or coal-bed moisture, and the other calculated to the dry-coal or moisture-free basis. There is also given the value of the unit-coal in British thermal units as derived by the formula previously explained[2].

---

[1] Parr, S. W., Chemical study of Illinois coals: Ill. Mining Investigations Bull. 3, 1916.

[2] Parr, S. W., Purchase and sale of Illinois coal on specification: Ill. State Geol. Surv. Bull. 29, 1914.

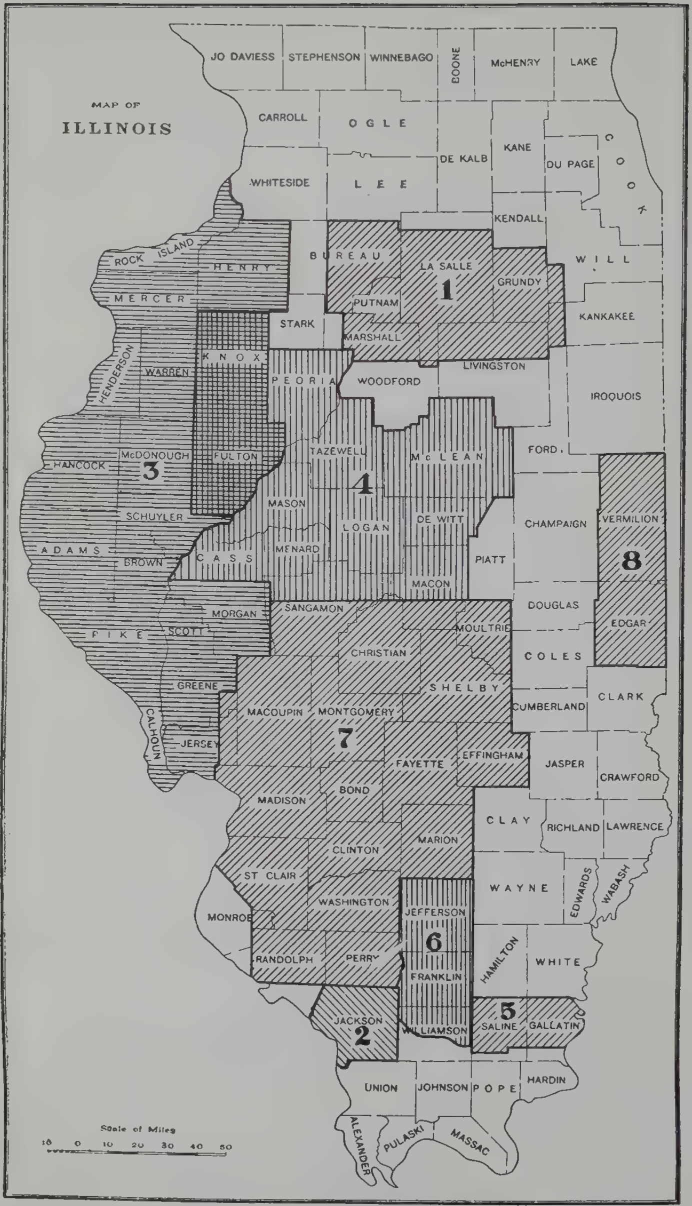

FIG. 1.—Districts for classification of coal samples

In Table 3 are presented the average analyses and heat values for separate mines and by counties grouped according to the districts shown in figure 1.

TABLE 1.—*Alphabetical arrangement of counties.*

County	Coal bed	District	County	Coal bed	District
Bond	6	VII	McLean	2, 5	IV
Bureau	2	I	Menard	5	IV
Calhoun	2	III	Mercer	1	III
Christian	1, 2, 6	IV, VII	Montgomery	6	VII
Clinton	6	VII	Moultrie	6	VII
Franklin	6	VI	Peoria	5	IV
Fulton	1, 5	III, IV	Perry	6	VI, VII
Gallatin	5, 6	V	Randolph	6	VII
Grundy	2	I	St. Clair	6	VII
Jackson	2, 6	II, VI	Saline	5	V
LaSalle	2, 5, 7	I	Sangamon	5, 6	IV, VII
Livingston	2, 5	I	Schuyler	1, 2	III
Logan	5	IV	Shelby	6	VII
Macon	5	IV	Tazewell	5	IV
Macoupin	6	VII	Vermilion	6, 7	VIII
Madison	6	VII	Washington	6	VII
Marion	6	VII	White	6	V
Marshall	2	I	Williamson	6	VI
McDonough	2	III			

Table 2.—*Analyses of mine samples (not exactly indicative of commercial output).*

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
					No. 1 Coal.							
5229	21	7/12	Christian	1	11.27	38.68	40.55	9.50	2.07	.33	11445	------
					Dry	43.59	45.70	10.71	2.33	.37	12898	14666
5230	21	7/12	Christian	1	11.52	38.78	41.01	8.69	2.42	.97	11648	------
					Dry	43.83	46.35	9.82	2.73	1.10	13163	14707
5231	21	7/12	Christian	1	11.13	39.21	41.26	8.40	2.56	.61	11715	------
					Dry	44.12	46.43	9.45	2.88	.69	13183	14779
12469	105	3/21	Fulton	1	11.38	38.66	39.51	10.45	4.52	.87	11436	------
					Dry	43.62	44.58	11.80	5.10	.98	12905	14979
12470	105	3/21	Fulton	1	11.42	38.17	40.07	10.34	4.76	.45	11409	------
					Dry	43.09	45.24	11.67	5.37	.51	12880	14934
12471	105	3/21	Fulton	1	10.84	38.42	40.91	9.83	5.61	.54	11554	------
					Dry	43.09	45.88	11.03	6.29	.61	12959	14939
5338	19	8/12	Mercer	1	13.23	40.29	37.20	9.28	4.37	.41	11104	------
					Dry	46.43	42.88	10.69	5.04	.47	12797	14641
5339	19	8/12	Mercer	1	15.24	37.66	35.73	11.37	4.80	1.47	10353	------
					Dry	44.44	42.15	13.41	5.66	1.73	12214	14478
5340	19	8/12	Mercer	1	15.15	39.06	38.48	7.31	3.30	.17	11252	------
					Dry	44.44	42.15	14.41	5.66	1.73	12214	14478
5363	19	8/12	Mercer	1	14.97	38.27	37.07	9.69	3.75	.33	9637	------
					Dry	46.03	45.36	8.61	3.89	.19	13260	14760
5364	19	8/12	Mercer	1	14.46	40.42	35.33	9.79	4.23	.69	10780	------
					Dry	44.99	43.61	11.40	4.95	.43	12749	14712
5365	19	8/12	Mercer	1	14.07	39.95	34.01	11.97	4.55	.78	10525	------
					Dry	47.24	41.32	11.44	4.94	.59	12603	14551
5359	18	8/12	Mercer	1	14.58	39.49	36.82	9.11	5.60	.15	10894	------
					Dry	46.49	39.59	13.92	5.29	.91	12247	14604
5360	18	8/12	Mercer	1	15.07	38.14	37.44	9.35	4.85	.34	10790	------
					Dry	46.23	43.09	10.68	6.56	.18	12754	14642
5361	18	8/12	Mercer	1	14.10	39.60	36.73	9.57	3.92	.23	10956	------
					Dry	44.91	44.01	11.02	5.71	.38	12705	14618
5371	17	8/12	Mercer	1	17.75	39.50	34.61	8.14	5.53	.86	10435	------
					Dry	48.03	42.08	9.89	6.72	1.05	12687	14373
5372	17	8/12	Mercer	1	17.50	38.78	33.66	10.06	4.51	.29	10238	------
					Dry	47.00	40.80	12.20	5.46	.35	12409	14372
					No. 2 Coal.							
5324	1	8/12	Bureau	2	16.65	36.66	38.58	8.11	3.40	.67	10740	------
					Dry	43.99	46.29	9.72	4.07	.80	12884	14533
5325	1	8/12	Bureau	2	15.08	40.12	36.35	8.45	3.68	.91	10831	------
					Dry	47.25	42.80	9.95	4.33	1.07	12754	14431
5326	1	8/12	Bureau	2	16.83	36.54	39.19	7.44	2.64	.89	10788	------
					Dry	43.93	47.12	8.95	3.17	1.07	12970	14463
5312	10	8/12	Bureau	2	14.88	38.69	37.25	9.08	3.83	1.07	10685	------
					Dry	45.45	43.76	10.79	4.50	1.25	12553	14357

Table 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5313	10	8/12	Bureau	2	17.43	38.07	39.44	5.06	2.68	.52	11070	------
					Dry	46.10	47.76	6.14	3.25	.63	13407	14462
5314	10	8/12	Bureau	2	16.07	39.68	38.36	5.89	2.96	.57	11216	------
					Dry	47.28	45.71	7.01	3.53	.63	13363	14571
5348	8	8/12	Bureau	2	15.19	39.67	38.69	6.45	2.20	.99	11206	------
					Dry	46.78	45.60	7.62	2.62	1.17	13213	14480
5349	8	8/12	Bureau	2	17.34	37.12	39.28	6.26	2.80	.49	11006	------
					Dry	44.90	47.52	7.58	3.38	.59	13314	14612
5350	8	8/12	Bureau	2	16.97	38.66	34.83	9.54	2.25	2.29	10397	------
					Dry	46.56	41.95	11.49	2.71	2.91	12522	14386
2641	230	7/09	Calhoun	2	10.62	38.13	39.65	11.60	4.96	------	11224	------
					Dry	42.67	44.36	12.97	5.55	------	12557	14806
5205	21	7/12	Christian	2	12.07	39.36	41.91	6.66	3.74	.07	11776	------
					Dry	44.77	47.66	7.57	4.26	.09	13393	14730
5206	21	7/12	Christian	2	12.53	38.00	40.62	8.25	3.67	.31	11389	------
					Dry	44.12	46.44	9.44	4.22	.35	13020	14641
5207	21	7/12	Christian	2	14.30	39.54	40.30	5.86	2.00	.24	11609	------
					Dry	46.14	47.02	6.84	2.33	.28	13544	14702
5367	6	8/12	Grundy	2	19.97	38.16	37.45	4.42	1.82	.65	10936	------
					Dry	47.68	46.79	5.53	2.27	.79	13664	14603
5368	6	8/12	Grundy	2	18.95	37.60	38.23	5.22	2.46	.64	10787	------
					Dry	46.39	47.16	6.45	3.04	.79	13309	14400
5369	6	8/12	Grundy	2	19.66	37.01	38.16	5.17	2.03	.83	10734	------
					Dry	46.06	47.50	6.44	2.53	1.03	13360	14337
5373	5	8/12	Grundy	2	17.29	38.61	36.69	7.41	2.87	1.44	10708	------
					Dry	46.68	44.36	8.96	3.47	1.74	12947	14447
5374	5	8/12	Grundy	2	13.73	39.87	42.19	4.21	2.04	1.47	11787	------
					Dry	46.22	48.90	4.88	2.37	1.71	13662	14466
5377	5	8/12	Grundy	2	17.01	39.48	36.74	6.77	3.32	1.05	10834	------
					Dry	47.57	44.27	8.16	4.00	1.27	13055	14446
5375	7	8/12	Grundy	2	16.84	38.37	41.19	3.60	1.74	.04	11508	------
					Dry	46.13	49.53	4.34	2.09	.05	13838	14583
5376	7	8/12	Grundy	2	15.81	39.28	39.77	6.13	2.30	.24	11212	------
					Dry	45.48	47.24	7.28	2.73	.28	13318	14545
5378	7	8/12	Grundy	2	16.23	38.71	40.61	4.45	2.47	.32	11461	------
					Dry	46.22	48.47	5.31	2.94	.38	13683	14610
5225	14	7/12	Jackson	2	7.72	35.09	48.56	8.63	2.01	.29	12248	------
					Dry	38.02	52.62	9.36	2.18	.31	13272	14839
5226	14	7/12	Jackson	2	8.77	32.78	50.58	7.87	2.00	.02	12253	------
					Dry	35.93	55.44	8.63	2.19	.03	13430	14885
5228	14	7/12	Jackson	2	9.18	34.70	51.58	4.54	.60	.05	12752	------
					Dry	38.20	56.80	5.00	.66	.06	14040	14867
5248	13	7/12	Jackson	2	9.88	33.23	52.43	4.46	.70	.33	12709	------
					Dry	36.87	58.18	4.95	.77	.36	14103	14926
5249	13	7/12	Jackson	2	10.91	33.51	51.20	4.38	1.14	.20	12503	------
					Dry	37.61	57.47	4.92	1.28	.23	14034	14863

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5250	13	7/12	Jackson	2	9.76	33.45	52.07	4.72	1.08	.51	12629	------
					Dry	37.06	57.71	5.23	1.20	.56	13996	14874
5351	12	7/12	Jackson	2	9.51	33.13	52.12	5.24	.66	.94	12500	------
					Dry	36.62	57.59	5.79	.73	1.03	13814	14758
5252	12	7/12	Jackson	2	9.37	33.39	49.29	7.95	2.11	.94	11972	------
					Dry	36.48	54.38	8.78	2.32	1.03	13208	14671
5253	12	7/12	Jackson	2	9.99	32.51	51.88	5.62	.62	.20	12308	------
					Dry	36.12	57.63	6.25	.69	.22	13673	14686
5496	16	8/12	Jackson	2	9.25	34.67	50.53	5.55	1.41	.13	12528	------
					Dry	38.20	55.68	6.12	1.56	.14	13804	14834
5497	16	8/12	Jackson	2	9.56	34.52	50.47	5.45	1.32	.27	12483	------
					Dry	38.16	55.83	6.01	1.46	.30	13781	14811
5498	16	8/12	Jackson	2	9.20	34.48	50.54	5.78	1.44	.19	12481	------
					Dry	37.97	55.66	6.37	1.59	.21	13746	14814
5286	15	8/12	Jackson	2	8.32	35.28	51.10	5.30	1.39	.19	12671	------
					Dry	38.49	55.74	5.77	1.53	.21	13822	14791
5287	15	8/12	Jackson	2	8.86	35.00	49.74	6.40	1.69	.07	12436	------
					Dry	38.40	54.57	7.03	1.85	.08	13645	14830
5288	15	8/12	Jackson	2	8.91	34.03	53.17	3.89	1.15	.07	12844	------
					Dry	37.36	58.37	4.27	1.26	.08	14101	14823
12662	104	6/21	Jackson	2	4.56	37.90	44.23	13.31	6.62	.03	11886	------
					Dry	39.71	46.35	13.94	6.94	.03	12106	14921
12663	104	6/21	Jackson	2	4.57	34.75	46.22	14.49	7.63	.04	11670	------
					Dry	36.41	48.41	15.18	8.00	.04	12229	14934
5388	2	8/12	LaSalle	2	14.22	39.49	36.94	9.35	4.46	.80	10887	------
					Dry	46.03	43.06	10.91	5.20	.93	12691	14562
5389	2	8/12	LaSalle	2	15.16	40.13	38.10	6.61	2.99	.64	11147	------
					Dry	47.32	44.88	7.80	3.51	.70	13138	14458
5390	2	8/12	LaSalle	2	14.43	40.01	35.89	9.67	4.47	1.03	10678	------
					Dry	46.75	41.94	11.31	5.23	1.21	12476	14404
5306	3	8/12	LaSalle	2	14.29	41.35	38.73	5.63	2.09	.19	11487	------
					Dry	48.24	45.18	6.58	2.44	.22	13401	14504
5307	3	8/12	LaSalle	2	16.05	37.03	37.06	9.86	4.35	.59	10459	------
					Dry	44.11	44.16	11.73	5.18	.70	12458	14440
5311	3	8/12	LaSalle	2	14.82	40.93	35.20	9.05	3.42	.99	10760	------
					Dry	48.05	41.33	10.62	4.02	1.17	12632	14401
5351	9	8/12	LaSalle	2	16.52	38.88	36.50	8.10	2.87	1.02	10686	------
					Dry	46.57	43.72	9.71	3.44	1.22	12800	14412
5352	9	8/12	LaSalle	2	17.77	39.05	34.15	9.03	3.92	1.25	10279	------
					Dry	47.48	41.55	10.97	4.76	1.52	12500	14334
5353	9	8/12	LaSalle	2	18.06	39.02	32.94	9.98	2.74	2.20	10209	------
					Dry	47.62	40.20	12.18	3.34	2.69	12460	14460
84450	102	3/22	LaSalle	2	14.5	36.0	41.7	7.8	3.5	.67	11130	------
					Dry	42.0	48.9	9.1	4.1	.79	13010	15564
84451	102	3/22	LaSalle	2	14.0	34.9	43.2	7.9	2.3	.90	11240	------
					Dry	40.6	50.3	9.1	2.7	1.04	13070	14584

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
84452	102	3/22	LaSalle........	2	15.7	33.9	41.9	8.5	4.0	.59	10800	------
					Dry	40.2	49.7	10.1	4.8	.70	12800	14528
10264	103	9/17	LaSalle........	2	12.61	38.89	42.36	6.14	2.66	------	11892	------
					Dry	44.51	48.46	7.03	3.04	------	13608	14830
10263	103	9/17	LaSalle........	2	12.19	39.92	40.18	7.17	2.56	------	11667	------
					Dry	45.47	45.75	8.78	2.91	------	13289	14780
1741	[1]B. M.	6/05	LaSalle........	2	13.87	37.26	38.56	10.31	3.44	------	10985	------
					Dry	43.26	44.77	11.97	3.99	------	12755	14792
1742	[1]B. M.	6/05	LaSalle........	2	15.55	36.21	40.66	7.58	3.01	------	------	------
					Dry	42.88	48.14	8.98	3.56	------	------	------
1779	[1]B. M.	6/05	LaSalle........	2	12.39	36.89	41.80	8.92	3.92	------	11399	------
					Dry	42.11	47.71	10.18	4.47	------	13012	14743
5357	4	8/12	Marshall.......	2	16.46	38.48	38.27	6.79	2.91	.28	11162	------
					Dry	46.06	45.80	8.14	3.48	.34	13360	14764
5356	4	8/12	Marshall.......	2	16.79	36.81	40.34	6.06	2.59	.41	11130	------
					Dry	44.23	48.49	7.28	3.11	.49	13375	14620
5358	4	8/12	Marshall.......	2	17.54	37.42	40.11	4.93	2.19	.42	11273	------
					Dry	45.37	48.63	6.00	2.56	.50	13669	14703
5412	11	8/12	Marshall.......	2	12.92	41.69	37.60	7.78	2.38	.64	11597	------
					Dry	47.87	43.19	8.94	2.73	.73	13319	14836
5413	11	8/12	Marshall.......	2	13.10	38.73	39.64	8.53	3.47	.65	11414	------
					Dry	44.56	45.61	9.83	3.99	.75	13134	14832
5414	11	8/12	Marshall.......	2	13.82	41.34	35.88	8.96	3.28	.50	11296	------
					Dry	47.97	41.64	10.39	3.81	.59	13106	14901
5232	22	7/12	McDonough....	2	19.35	31.70	40.61	8.34	2.31	.37	10392	------
					Dry	39.35	50.40	10.35	2.87	.46	12898	14605
5233	22	7/12	McDonough....	2	16.46	33.94	42.46	7.14	1.71	.11	11064	------
					Dry	40.63	50.83	8.54	2.04	.14	13246	14660
5234	22	7/12	McDonough....	2	16.39	34.26	41.36	7.99	2.04	.33	10977	------
					Dry	40.97	49.47	9.56	2.44	.40	13130	14725
9728	213	11/16	McDonough....	2	14.89	35.48	40.75	8.88	3.78	------	10969	------
					Dry	41.68	47.88	10.44	4.43	------	12887	14678
9729	213	11/16	McDonough....	2	16.83	34.68	39.79	8.70	3.94	------	10628	------
					Dry	41.71	47.83	10.46	4.74	------	12778	14565
5426	100	8/12	McLean........	2	10.13	45.00	35.92	8.95	3.27	.74	11710	------
					Dry	50.07	39.97	9.96	3.59	.82	13029	14723
5427	100	8/12	McLean........	2	11.34	40.05	39.18	9.43	3.18	.90	11394	------
					Dry	45.17	44.19	10.64	3.58	1.01	12851	14643
5428	100	8/12	McLean........	2	10.61	41.87	35.94	11.58	3.79	.92	11225	------
					Dry	46.84	40.21	12.95	4.24	1.03	12557	14752
5429	100	8/12	McLean........	2	12.31	42.17	38.03	7.49	2.69	.94	11636	------
					Dry	48.09	43.37	8.54	3.07	1.07	13270	14722
5430	100	8/12	McLean........	2	12.00	42.00	37.96	8.04	2.37	1.23	11634	------
					Dry	47.73	43.14	9.13	2.70	1.40	13220	14759

[1] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 85, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5433	100	8/12	McLean--------	2	11.27 Dry	42.17 47.53	39.27 44.25	7.29 8.22	2.91 3.28	1.12 1.26	11784 13279	------ 14684
3044	[2]B. M. 55	3/06	McLean--------	2	10.25 Dry	35.88 39.98	40.11 44.69	13.76 15.33	2.80 3.12	------ ------	11149 12422	------ 15028
3045	[2]B. M. 55	3/06	McLean--------	2	9.88 Dry	35.99 39.93	38.22 42.42	15.91 17.65	3.15 3.50	------ ------	------- -------	------ ------
9709	214	11/16	Schuyler-------	2	12.34 Dry	38.11 43.48	42.29 48.24	7.26 8.28	4.32 4.92	------ ------	11841 13507	------ 15011
9708	214	11/16	Schuyler-------	2	12.73 Dry	37.56 43.04	41.88 47.99	7.83 8.97	4.77 5.46	------ ------	11621 13316	------ 14924
					No. 5 Coal.							
5283	31	8/12	Fulton---------	5	15.18 Dry	37.17 43.82	35.17 41.45	12.48 14.73	3.45 4.07	1.70 2.00	10201 12026	------ 14441
5284	31	8/12	Fulton---------	5	16.94 Dry	35.68 42.95	37.15 44.73	10.23 12.32	2.98 3.59	1.31 1.57	10314 12418	------ 14446
5285	31	8/12	Fulton---------	5	18.42 Dry	34.98 42.88	37.66 46.15	8.94 10.97	2.33 2.85	.86 1.06	10270 12587	------ 14371
5296	31	8/12	Fulton---------	5	16.82 Dry	37.28 44.81	33.45 40.23	12.45 14.96	2.84 3.42	1.69 2.02	10580 12038	------ 14479
5298	31	8/12	Fulton---------	5	16.52 Dry	37.17 44.52	36.54 43.78	9.77 11.70	3.91 4.69	.81 .97	10394 12451	------ 14409
5341	31	8/12	Fulton---------	5	17.37 Dry	35.71 43.22	37.86 45.82	9.06 10.96	2.34 2.83	1.14 1.38	10420 12610	------ 14398
5293	29	8/12	Fulton---------	5	17.13 Dry	36.23 43.72	34.44 41.55	12.20 14.73	3.03 3.66	1.79 2.16	9846 11882	------ 14252
5297	29	8/12	Fulton---------	5	16.59 Dry	35.98 43.14	37.20 44.61	10.23 12.25	4.07 4.88	1.77 2.12	10271 12314	------ 14354
5300	29	8/12	Fulton---------	5	15.41 Dry	35.67 42.16	39.04 46.15	9.88 11.69	3.31 3.92	.52 .61	10579 12505	------ 14443
5292	28	8/12	Fulton---------	5	17.39 Dry	37.00 44.79	35.69 43.20	9.92 12.01	2.74 3.28	1.14 1.36	10273 12435	------ 14416
5295	28	8/12	Fulton---------	5	16.33 Dry	36.27 43.34	36.58 43.72	10.82 12.94	3.40 4.06	1.94 2.32	10246 12247	------ 14371
5299	28	8/12	Fulton---------	5	16.33 Dry	36.75 43.92	38.02 45.44	8.90 10.64	2.59 3.10	1.02 1.22	10604 12674	------ 14421
5342	32	8/12	Fulton---------	5	13.66 Dry	38.46 44.54	37.06 42.92	10.82 12.54	3.64 4.22	1.26 1.46	10689 12379	------ 14462
5343	32	8/12	Fulton---------	5	14.53 Dry	37.46 43.83	38.35 44.87	9.66 11.30	3.18 3.72	1.60 1.87	10804 12641	------ 14525
5344	32	8/12	Fulton---------	5	15.80 Dry	35.84 42.56	37.67 44.74	10.69 12.70	3.00 3.57	1.79 2.12	10460 12423	------ 14520
5345	30	8/12	Fulton---------	5	16.36 Dry	33.91 40.54	38.19 45.66	11.54 13.80	2.93 3.50	1.27 1.51	10186 12179	------ 14431
5346	30	8/12	Fulton---------	5	16.33 Dry	35.50 42.42	37.01 44.23	11.16 13.35	2.89 3.45	1.84 2.20	10220 12213	------ 14389

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[2] Ibid.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	Conuty	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5347	30	8/12	Fulton----------	5	15.85 Dry	36.12 42.92	38.12 45.30	9.91 11.78	3.36 4.00	1.47 1.75	10494 12471	------ 14386
12442	110	3/21	Fulton----------	5	15.43 Dry	33.62 39.76	39.47 46.67	11.48 13.57	2.50 2.66	1.41 1.67	10389 12285	------ 14473
12443	111	3/21	Fulton----------	5	14.43 Dry	34.60 40.43	39.09 45.69	11.88 13.88	2.82 3.29	2.45 2.86	10320 12061	------ 14297
12444	111	3/21	Fulton----------	5	15.00 Dry	33.10 38.94	37.31 43.89	14.59 17.17	3.38 3.98	2.86 3.36	9834 11569	------ 14300
12445	111	3/21	Fulton----------	5	14.69 Dry	34.07 39.94	40.18 47.09	11.06 12.97	2.83 3.32	1.75 2.05	10383 12172	------ 14266
12446	111	3/21	Fulton----------	5	14.52 Dry	34.46 40.31	37.64 44.04	13.38 15.65	2.91 3.40	2.74 3.21	10045 11752	------ 14261
12447	111	3/21	Fulton----------	5	14.75 Dry	33.18 38.92	38.89 45.62	13.18 15.46	3.70 4.34	1.54 1.81	9869 11577	------ 14298
12448	111	3/21	Fulton----------	5	14.28 Dry	33.93 40.75	38.76 45.22	12.03 14.03	2.56 2.99	1.98 2.31	10329 12061	------ 14316
12472	112	3/21	Fulton----------	5	15.32 Dry	35.12 41.48	38.05 44.93	11.51 13.59	2.59 3.06	1.41 1.66	10482 12379	------ 14617
12473	112	3/21	Fulton----------	5	15.09 Dry	35.37 41.66	39.41 46.41	10.13 11.93	2.68 3.16	1.79 1.66	10741 12650	------ 14631
12474	112	3/21	Fulton----------	5	15.56 Dry	35.68 42.26	38.92 46.09	9.84 11.65	2.43 2.88	1.33 1.58	10753 12735	------ 14668
12475	112	3/21	Fulton----------	5	14.56 Dry	35.37 41.40	38.98 45.62	11.09 12.98	2.72 3.19	1.38 1.62	10581 12384	------ 14512
12476	112	3/21	Fulton----------	5	15.39 Dry	33.82 39.97	38.77 45.82	12.02 14.21	3.40 4.02	1.67 1.97	10338 12219	------ 14565
12477	112	3/21	Fulton----------	5	15.66 Dry	34.65 41.08	37.56 44.59	12.13 14.38	2.93 3.47	1.88 2.23	10242 12144	------ 14583
12439	113	3/21	Fulton----------	5	13.37 Dry	36.03 41.59	39.03 45.06	11.57 13.35	3.06 3.52	1.46 1.69	10787 12452	------ 14670
12440	113	3/21	Fulton----------	5	14.44 Dry	34.71 40.57	38.58 45.09	12.27 14.34	2.17 2.54	1.80 2.10	10578 12364	------ 14683
12441	113	3/21	Fulton----------	5	14.96 Dry	33.65 39.57	39.96 46.99	11.43 13.44	4.32 5.08	1.11 1.30	10502 12350	------ 14616
12459	114	3/21	Fulton----------	5	14.57 Dry	35.24 41.25	39.58 46.33	10.61 12.42	2.89 3.38	1.00 1.17	10562 12363	------ 14391
12460	114	3/21	Fulton----------	5	16.16 Dry	35.65 42.52	37.89 45.19	10.30 12.29	2.50 2.98	1.56 1.86	10422 12931	------ 14434
12461	114	3/21	Fulton----------	5	13.35 Dry	37.84 43.67	39.86 46.00	8.95 10.33	2.22 2.56	1.77 2.04	10843 12514	------ 14150
12462	114	3/21	Fulton----------	5	15.86 Dry	35.20 41.84	37.32 44.35	11.62 13.81	3.49 4.15	1.31 1.56	10198 12120	------ 14380
12463	114	3/21	Fulton----------	5	14.34 Dry	35.09 40.96	36.72 42.87	13.85 16.17	3.84 4.48	2.47 2.89	9944 11609	------ 14217
12464	114	3/21	Fulton----------	5	14.62 Dry	36.18 42.38	39.21 45.92	9.99 11.70	2.43 2.85	1.49 1.74	10719 12555	------ 14465

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
84406	115	2/22	Fulton----------	5	15.7	33.2	38.7	12.4	3.6	1.57	10270	------
					Dry	39.3	46.0	14.7	4.3	1.86	12180	14511
84407	115	2/22	Fulton----------	5	14.8	33.8	42.3	9.1	2.6	.75	10950	------
					Dry	39.7	49.6	10.7	3.1	.88	12860	14649
12436	116	3/21	Fulton----------	5	15.88	33.96	38.75	11.41	4.38	.92	10330	------
					Dry	40.37	46.07	13.56	5.21	1.10	12280	14569
12437	116	3/21	Fulton----------	5	16.68	35.46	37.90	9.96	3.82	.61	10464	------
					Dry	42.56	45.49	11.95	4.58	.74	12559	14579
12438	116	3/21	Fulton----------	5	14.53	35.68	38.23	11.56	3.45	1.00	10608	------
					Dry	41.74	44.73	13.53	4.04	1.17	12411	14679
84409	117	2/22	Fulton----------	5	13.5	34.4	38.8	13.3	3.5	------	10410	------
					Dry	39.8	44.8	15.4	4.1	------	12040	14589
84446	118	3/22	Fulton----------	5	11.6	36.4	40.4	11.6	4.1	.92	11070	------
					Dry	41.1	45.7	13.2	4.6	1.04	12510	14758
84447	118	3/22	Fulton----------	5	13.6	34.7	41.4	10.3	3.3	.83	10950	------
					Dry	40.2	47.9	11.9	3.8	.97	12670	14673
84448	118	3/22	Fulton----------	5	13.1	34.7	39.5	12.7	4.0	1.34	10690	------
					Dry	39.9	45.4	14.7	4.7	1.54	12310	14808
4345	[3]	12/06	Fulton----------	5	15.27	32.91	11.46	10.36	3.01	------	------	------
					Dry	38.84	48.93	12.23	3.55	------	------	------
4346	[3]	12/06	Fulton----------	5	15.67	31.43	43.10	9.80	2.99	------	10620	------
					Dry	37.28	51.11	11.61	3.55	------	12593	14519
5025	47	6/12	Gallatin---------	5	5.37	36.54	45.10	12.99	3.99	1.38	11883	------
					Dry	38.62	47.65	13.73	4.22	1.45	12558	14900
5029	47	6/12	Gallatin---------	5	5.57	35.49	48.53	10.41	3.12	.78	12338	------
					Dry	37.59	51.39	11.02	3.31	.83	13066	14953
5032	47	6/12	Gallatin---------	5	6.21	35.29	46.49	12.02	3.30	.87	11938	------
					Dry	37.61	49.57	12.82	3.52	.93	12728	14903
5492	----------	8/12	Gallatin---------	5	4.20	34.41	52.63	8.76	2.85	.01	12997	------
					Dry	35.92	54.92	9.16	2.97	.01	13566	15164
5493	----------	8/12	Gallatin---------	5	4.07	33.99	52.96	8.98	3.61	.03	12975	------
					Dry	35.43	55.21	9.36	3.76	.03	13526	15186
5512	----------	8/12	Gallatin---------	5	3.68	37.83	48.18	10.32	4.55	.04	12818	------
					Dry	39.26	50.02	10.72	4.73	.04	13307	15078
5521	----------	8/12	Gallatin---------	5	3.94	38.13	45.95	11.98	3.53	.03	12449	------
					Dry	39.70	47.82	12.48	3.67	.03	12958	15117
5522	----------	8/12	Gallatin---------	[4]	7.15	34.34	53.32	5.19	.84	.03	13035	------
					Dry	36.99	57.42	5.59	.90	.03	14038	14970
5523	----------	8/12	Gallatin---------	----	4.73	33.91	48.65	11.71	4.78	.04	12429	------
					Dry	35.59	52.12	12.29	5.02	.04	13045	15240
5530	----------	8/12	Gallatin---------	----	4.03	33.71	51.84	10.41	4.19	.02	12783	------
					Dry	35.13	54.01	10.86	4.37	.02	13319	15256
12940	135	7/21	Gallatin---------	5	4.37	34.39	49.23	12.01	3.85	.35	12270	------
					Dry	35.96	51.48	12.56	4.03	.37	12631	14995

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[3] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 85, 1913.
[4] This and the two following samples are from the "Ice House" coal of Kentucky reports.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12941	135	7/21	Gallatin	5	4.04 Dry	35.68 37.18	50.92 53.06	9.36 9.76	3.23 3.37	.24 .24	12828 13200	------ 15066
12942	135	7/21	Gallatin	5	3.49 Dry	36.09 37.39	50.54 52.37	9.88 10.24	3.04 3.15	.18 .18	12707 13162	------ 14912
23425	[5]B. M. 4	11/15	Gallatin	5	3.93 Dry	36.82 38.33	51.04 53.12	8.21 8.55	2.80 2.91	------ ------	13106 13642	------ 15134
5391	----------	8/12	LaSalle	5	15.52 Dry	41.56 49.18	32.57 38.55	10.35 12.27	4.08 4.83	.27 .34	10425 12400	------ 14384
5392	----------	8/12	LaSalle	5	14.13 Dry	39.42 45.90	35.96 41.89	10.49 12.21	3.22 3.75	.96 1.12	10636 12387	------ 14393
5393	----------	8/12	LaSalle	5	14.64 Dry	43.01 50.38	34.25 40.12	8.10 9.50	2.83 3.32	.56 .66	10961 12841	------ 14415
10519	215	8/18	Livingston	5	10.22 Dry	36.56 40.72	42.14 46.94	11.08 12.34	3.09 3.44	------ ------	11630 12955	------ 15077
10523	215	8/18	Livingston	5	10.05 Dry	32.49 38.12	37.59 41.80	19.87 22.08	7.61 8.46	------ ------	10125 11256	------ 15151
10524	215	8/18	Livingston	5	7.95 Dry	38.03 41.31	43.55 47.31	10.47 11.38	3.52 3.82	------ ------	12020 13057	------ 15026
10520	216	8/18	Livingston	5	13.23 Dry	36.90 41.71	39.16 45.13	11.42 13.16	1.46 1.69	------ ------	10924 12590	------ 14738
10521	216	8/18	Livingston	5	14.03 Dry	36.36 42.29	39.69 46.17	9.92 11.54	2.74 3.18	------ ------	11124 12939	------ 14899
10522	216	8/18	Livingston	5	14.04 Dry	34.76 40.44	38.03 44.24	13.17 15.32	5.25 6.11	------ ------	10502 12216	------ 14871
5263	33	8/12	Logan	5	14.64 Dry	37.87 44.36	35.56 41.66	11.93 13.98	3.60 4.22	1.10 1.28	10400 12183	------ 14497
5264	33	8/12	Logan	5	13.98 Dry	36.86 42.84	37.98 44.16	11.18 13.00	3.14 3.65	1.43 1.67	10549 12264	------ 14391
5265	33	8/12	Logan	5	13.99 Dry	36.85 42.85	38.17 44.37	10.99 12.78	3.26 3.79	1.32 1.53	10519 12230	------ 14313
81591	109	9/21	Logan	5	14.36 Dry	35.36 41.29	39.95 46.65	10.33 12.06	2.73 3.19	1.20 1.40	10790 12599	------ 14595
81592	109	9/21	Logan	5	13.70 Dry	35.46 41.09	40.38 46.79	10.46 12.12	3.38 3.92	1.11 1.29	10813 12530	------ 14553
81593	109	9/21	Logan	5	12.55 Dry	35.93 41.09	42.13 48.17	9.39 10.74	2.76 2.16	.84 .96	11169 12772	------ 14643
2881	[6]B. M. 37	2/06	Logan	5	14.77 Dry	32.90 38.60	39.75 46.64	12.58 14.76	3.95 4.63	------ ------	10406 12209	------ 14687
2882	[6]B. M. 37	2/06	Logan	5	15.52 Dry	32.27 38.20	39.86 47.18	12.35 14.62	3.65 4.32	------ ------	------- -------	------ ------
3003	[6]B. M. 37	2/06	Logan	5	15.68 Dry	32.41 38.44	39.82 47.22	12.09 14.34	3.51 4.16	------ ------	10337 12260	------ 14656
5200	42	7/12	Macon	5	13.52 Dry	36.72 42.46	39.66 45.86	10.10 11.68	4.23 4.95	.09 .11	10646 12443	------ 14405

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[5] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 34, 1918.
[6] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 85, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5201	42	7/12	Macon	5	13.62	37.72	40.34	8.32	3.39	.00	11046	------
					Dry	43.68	46.70	9.62	3.93	.00	12788	14403
5202	42	7/12	Macon	5	14.36	38.06	39.35	9.33	3.87	.19	10963	------
					Dry	43.88	45.37	10.75	4.46	.22	12638	14447
5244	41	7/12	Macon	5	14.76	35.46	38.08	11.70	3.24	.90	10390	------
					Dry	41.60	44.67	13.73	3.81	1.06	12189	14443
5245	41	7/12	Macon	5	14.54	36.33	38.01	11.12	3.47	.68	10465	------
					Dry	42.51	44.47	13.01	4.06	.79	12244	14385
5346	41	7/12	Macon	5	14.14	36.21	38.07	11.58	3.24	1.12	10493	------
					Dry	42.18	44.34	13.48	3.77	1.31	12210	14433
81595	123	9/21	Macon	5	13.10	34.64	43.36	8.90	2.73	.21	10934	------
					Dry	39.86	49.90	10.24	3.14	.24	12582	14247
81596	123	9/21	Macon	5	12.67	35.75	43.08	8.50	3.32	.03	11103	------
					Dry	40.94	49.33	9.73	3.80	.03	12714	14331
81597	123	9/21	Macon	5	12.71	35.98	42.79	8.52	3.66	.17	11093	------
					Dry	41.22	49.02	9.76	4.19	.19	12708	14338
5190	34	8/12	Menard	5	16.29	36.66	38.73	8.32	3.65	.59	10747	------
					Dry	43.80	46.26	9.94	4.36	.71	12838	14528
5191	34	7/12	Menard	5	15.44	36.38	39.71	8.47	3.34	.26	10841	------
					Dry	43.03	46.96	10.01	3.95	.31	12820	14505
5192	34	7/12	Menard	5	20.27	34.58	37.43	7.72	3.31	.63	9919	------
					Dry	43.37	46.94	9.69	4.16	.79	12441	14402
5431	100	8/12	McLean	5	12.88	38.84	35.80	12.48	3.60	1.17	10601	------
					Dry	44.58	41.09	14.33	4.14	1.35	12168	14544
5432	100	8/12	McLean	5	13.34	38.39	36.72	11.55	3.59	1.31	10743	------
					Dry	44.30	42.37	13.33	4.14	1.51	12397	14629
5434	100	8/12	McLean	5	13.73	36.79	36.14	13.34	3.99	1.19	10399	------
					Dry	42.64	41.89	15.47	4.62	1.30	12054	14639
5289	25	8/12	Peoria	5	14.23	36.65	37.04	12.08	3.39	1.55	10483	------
					Dry	42.73	43.18	14.09	3.96	1.81	12220	14553
5290	25	8/12	Peoria	5	14.54	37.41	37.32	10.73	3.27	1.18	10705	------
					Dry	43.77	43.67	12.56	3.82	1.38	12526	14625
5291	25	8/12	Peoria	5	16.00	36.46	37.28	10.26	3.65	.90	10583	------
					Dry	43.41	44.38	12.21	4.35	1.07	12598	14664
5303	26	8/12	Peoria	5	16.00	36.06	37.54	10.40	2.90	1.27	10515	------
					Dry	42.93	44.69	12.38	3.46	1.51	12518	14773
5304	26	8/12	Peoria	5	14.23	37.41	37.36	11.00	3.14	2.17	10573	------
					Dry	43.62	43.56	12.82	3.66	2.53	12327	14433
5305	26	8/12	Peoria	5	14.76	35.95	35.34	13.95	3.19	2.00	10173	------
					Dry	42.18	41.46	16.36	3.74	2.34	11935	14636
84560	106	3/22	Peoria	5	13.5	30.7	45.5	10.3	3.2	.86	10900	------
					Dry	35.5	52.6	11.9	3.7	1.0	12600	14586
84561	106	3/22	Peoria	5	15.1	29.7	45.8	9.4	3.6	.43	10870	------
					Dry	35.0	53.9	11.1	4.3	.50	12800	14693
84562	106	3/22	Peoria	5	11.6	30.6	43.1	14.7	4.6	1.86	10540	------
					Dry	34.6	48.8	16.6	5.2	2.11	11930	14733

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
84230	107	3/22	Peoria	5	13.0	35.4	40.9	10.7	3.0	1.91	10830	------
					Dry	40.6	47.1	12.3	3.4	2.19	12450	14474
84231	107	3/22	Peoria	5	14.9	33.5	39.1	12.5	3.0	2.17	10450	------
					Dry	39.3	46.0	14.7	3.5	2.55	12280	14728
84232	107	3/22	Peoria	5	14.4	34.8	39.9	10.9	2.9	1.23	10740	------
					Dry	40.6	46.7	12.7	3.3	1.43	12540	14651
21032	[7]B. M. 2	2/15	Peoria	5	15.66	34.74	40.38	9.22	2.64	------	10798	------
					Dry	41.19	47.88	10.93	3.13	------	12803	14804
21033	[7]B. M. 2	2/15	Peoria	5	15.38	34.51	39.48	10.63	2.75	------	10645	------
					Dry	40.78	46.66	12.56	3.25	------	12580	14671
21034	[7]B. M. 2	2/15	Peoria	5	15.34	34.25	40.80	9.61	3.11	------	10741	------
					Dry	40.46	48.19	11.35	3.67	------	12686	14584
21035	[7]B. M. 2	2/15	Peoria	5	15.44	34.72	39.81	10.03	2.85	------	10744	------
					Dry	41.06	47.08	11.86	3.37	------	12706	14691
22982	[7]B. M. 3	10/15	Peoria	5	15.03	34.56	39.05	11.36	2.64	------	10490	------
					Dry	40.67	45.96	13.37	3.11	------	12346	14538
22983	[7]B. M. 3	10/15	Peoria	5	15.41	33.87	38.85	11.87	2.88	------	10386	------
					Dry	40.04	45.93	14.03	3.40	------	12278	14593
22984	[7]B. M. 3	10/15	Peoria	5	15.51	34.77	38.69	11.03	2.62	------	10489	------
					Dry	41.15	45.79	13.06	3.10	------	12415	14562
22985	[7]B. M. 3	10/15	Peoria	5	15.57	34.08	38.18	12.17	3.42	------	10283	------
					Dry	40.36	45.23	14.41	4.05	------	12179	14566
22986	[7]B. M. 3	10/15	Peoria	5	15.41	34.34	38.52	11.73	2.97	------	10422	------
					Dry	40.60	45.53	13.87	3.51	------	12321	14618
4985	43	6/12	Saline	5	6.34	37.72	48.20	7.74	2.03	.61	12620	------
					Dry	40.27	51.46	8.27	2.16	.65	13474	14869
4986	43	6/12	Saline	5	6.40	37.11	49.59	6.90	2.27	.40	12678	------
					Dry	39.65	52.97	7.38	2.43	.43	13546	14800
4987	43	6/12	Saline	5	8.85	32.53	51.52	7.10	.92	.66	12321	------
					Dry	35.65	56.57	7.78	1.00	.72	13502	14774
4989	43	6/12	Saline	5	6.80	35.06	50.39	7.75	2.30	.03	12514	------
					Dry	37.61	54.07	8.32	2.46	.03	13428	14853
4990	43	6/12	Saline	5	6.02	38.23	47.53	8.22	2.67	.45	12538	------
					Dry	40.68	50.58	8.74	2.84	.48	13341	14831
4992	43	6/12	Saline	5	7.39	35.38	50.73	6.50	2.15	.01	12642	------
					Dry	38.20	54.78	7.02	2.32	.01	13650	14848
4991	44	6/12	Saline	5	6.49	35.85	50.46	7.20	2.82	.01	12634	------
					Dry	38.34	53.97	7.69	3.02	.01	13511	14841
4993	44	6/12	Saline	5	6.71	35.68	49.64	7.97	2.69	.00	12482	------
					Dry	38.24	53.21	8.55	2.88	.00	13379	14839
4994	44	6/12	Saline	5	6.90	34.42	48.55	10.13	2.16	.03	12088	------
					Dry	36.97	52.16	10.87	2.32	.03	12984	14793

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[7] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 35, 1918.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
4997	45	6/12	Saline	5	6.71	35.59	49.98	7.72	2.38	.14	12092	------
					Dry	38.14	53.59	8.27	2.55	.16	13332	14725
4909	45	6/12	Saline	5	7.45	34.18	49.88	8.49	2.78	.01	12336	------
					Dry	36.94	53.90	9.16	3.01	.01	13329	14901
5001	45	6/12	Saline	5	6.94	34.56	50.93	7.57	2.30	.16	12485	------
					Dry	37.14	54.72	8.14	2.46	.18	13415	14792
995	48	6/12	Saline	5	7.57	34.36	48.30	9.77	2.42	1.75	11956	------
					Dry	37.18	52.25	10.57	2.62	1.89	12934	14692
5002	48	6/12	Saline	5	7.45	33.71	51.27	7.57	2.63	.31	12400	------
					Dry	36.42	55.40	8.18	2.84	.35	13398	14794
5010	48	6/12	Saline	5	7.99	33.63	51.20	7.18	2.61	.05	12346	------
					Dry	36.55	55.65	7.80	2.84	.05	13419	14732
5012	49	6/12	Saline	5	5.19	38.37	45.92	10.52	4.06	.46	12260	------
					Dry	40.47	48.43	11.10	4.28	.49	12932	14847
5015	49	6/12	Saline	5	5.52	36.89	45.89	11.70	4.97	.72	11962	------
					Dry	39.04	48.58	12.38	5.26	.76	12662	14809
5016	49	6/12	Saline	5	4.90	38.93	45.90	10.27	4.77	.47	12355	------
					Dry	40.94	48.26	10.80	5.01	.49	12991	14815
5019	46	6/12	Saline	5	8.08	35.26	48.25	8.41	2.60	.38	12192	------
					Dry	38.35	52.50	9.15	2.83	.41	13263	14818
5020	46	6/12	Saline	5	7.70	35.48	48.66	8.16	2.52	.32	12304	------
					Dry	38.44	52.72	8.84	2.74	.36	13331	14833
5021	46	6/12	Saline	5	8.25	34.98	47.73	9.04	2.40	.85	11964	------
					Dry	38.12	52.03	9.85	2.61	.92	13040	14684
5022	46	6/12	Saline	5	7.72	34.09	49.22	8.97	3.31	.23	12050	------
					Dry	36.94	53.34	9.72	3.58	.25	13057	14716
5023	46	6/12	Saline	5	8.14	34.60	48.10	9.16	2.42	.74	11989	------
					Dry	37.66	52.36	9.98	2.64	.80	13051	14717
5024	46	6/12	Saline	5	7.85	33.72	49.30	9.13	3.48	.24	11971	------
					Dry	36.59	53.50	9.91	3.78	.26	12990	14676
12931	124	7/21	Saline	5	7.10	33.34	51.33	8.14	2.58	.13	12354	------
					Dry	35.93	55.30	8.77	2.78	.14	13313	14798
12932	124	7/21	Saline	5	6.78	33.62	51.96	7.64	2.40	.11	12490	------
					Dry	36.07	55.74	8.19	2.58	.11	13399	14788
12933	124	7/21	Saline	5	6.62	32.79	52.27	8.32	1.74	.42	12463	------
					Dry	35.11	55.98	8.91	1.86	.45	13347	14832
12934	125	7/21	Saline	5	6.65	33.52	52.48	7.35	1.93	.13	12609	------
					Dry	35.91	56.22	7.87	2.07	.13	13507	14834
12935	125	7/21	Saline	5	6.28	33.35	51.48	8.89	3.07	.09	12357	------
					Dry	35.58	54.93	9.49	3.28	.09	13185	14805
12936	125	7/21	Saline	5	6.85	33.65	52.28	7.22	2.11	.05	12612	------
					Dry	36.13	56.12	7.75	2.27	.05	13539	14854
12937	126	7/21	Saline	5	5.75	33.90	53.21	7.14	2.29	.04	12624	------
					Dry	35.97	56.46	7.57	2.43	.04	13394	14668
12938	126	7/21	Saline	5	6.13	34.28	51.83	7.76	2.75	.27	12615	------
					Dry	36.52	55.22	8.26	2.60	.29	13439	14830

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12939	126	7/21	Saline	5	6.18	33.97	51.99	7.86	2.65	.16	12508	------
					Dry	36.21	55.42	8.37	2.82	.17	13191	14753
12901	127	7/21	Saline	5	5.51	33.34	53.39	7.76	1.92	.34	12687	------
					Dry	35.28	56.51	8.21	2.03	.36	13427	14771
12902	127	7/21	Saline	5	6.05	34.38	51.87	7.70	1.98	.42	12580	------
					Dry	36.59	55.21	8.20	2.11	.44	13390	14765
12903	127	7/21	Saline	5	5.50	33.64	52.49	8.37	2.51	.51	12576	------
					Dry	35.60	55.54	8.86	2.66	.54	13308	14806
12911	128	7/21	Saline	5	6.52	33.57	52.37	7.54	2.57	.03	12552	------
					Dry	35.91	56.02	8.07	2.75	.03	13428	14805
12912	128	7/21	Saline	5	6.84	30.30	48.02	14.84	1.46	.03	11343	------
					Dry	32.52	51.55	15.93	1.57	.03	12176	14764
12913	128	7/21	Saline	5	6.17	32.87	53.54	7.42	1.60	.13	12631	------
					Dry	35.03	57.06	7.91	1.71	.14	13462	14777
12917	129	7/21	Saline	5	5.62	34.61	52.52	7.25	2.02	.08	12781	------
					Dry	36.67	55.65	7.68	2.14	.09	13542	14840
12918	129	7/21	Saline	5	5.75	35.01	52.65	6.59	2.05	.05	12800	------
					Dry	37.15	55.86	6.99	2.18	.05	13581	14927
12919	129	7/21	Saline	5	6.58	32.89	53.29	7.24	2.06	.14	12565	------
					Dry	35.21	57.14	7.75	2.20	.15	13450	14754
12914	130	7/21	Saline	5	6.05	33.67	51.48	8.80	2.72	.34	12401	------
					Dry	35.84	54.79	9.37	2.90	.35	13200	14786
12915	130	7/21	Saline	5	6.69	32.54	51.44	9.33	2.62	.06	12225	------
					Dry	34.88	55.13	9.99	2.81	.07	13101	14785
12916	130	7/21	Saline	5	5.93	33.79	51.51	8.77	2.63	.10	12393	------
					Dry	35.92	54.76	9.32	2.80	.11	13774	14746
5494	131	8/12	Saline	5	3.72	34.44	52.91	8.93	3.76	.03	13032	------
					Dry	35.77	54.96	9.27	3.90	.03	13535	15186
5530	132	8/12	Saline	5	4.03	33.71	51.84	10.42	4.19	.02	12783	------
					Dry	35.13	54.01	10.86	4.37	.02	13319	15255
5529	133	8/12	Saline	5	3.40	33.33	55.18	8.09	4.25	.03	13401	------
					Dry	34.50	57.12	8.38	4.40	.03	13872	15420
4413	[8]B. M. 5	1/07	Saline	5	7.55	33.85	51.45	7.15	1.56	------	------	------
					Dry	36.61	55.66	7.73	1.69	------	------	------
4414	[8]B. M. 5	1/07	Saline	5	7.51	32.81	52.20	7.48	1.58	------	12686	------
					Dry	35.47	56.44	8.09	1.71	------	13716	15090
7420	[8]B. M. 5	1/07	Saline	5	6.98	31.64	53.41	7.97	------	------	------	------
					Dry	34.01	57.42	8.57	------	------	------	------
7421	[8]B. M. 5	1/07	Saline	5	7.40	31.28	54.74	6.58	------	------	------	------
					Dry	33.78	59.11	7.11	------	------	------	------
4622	[8]B. M. 5	1/07	Saline	5	7.81	33.54	50.27	8.38	2.36	------	12418	------
					Dry	36.38	54.53	9.09	2.56	------	13469	15552
4636	[8]B. M. 5	1/07	Saline	5	9.33	30.92	47.86	11.89	2.76	------	11572	------
					Dry	34.10	52.79	13.11	3.04	------	12764	14984

[8] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 90, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
7501	[8]B. M. 6	3/09	Saline	5	6.01 Dry	32.37 34.44	54.32 57.79	7.30 7.77	1.66 1.77	------ ------	12793 13610	------ 14916
7502	[8]B. M. 6	3/09	Saline	5	5.56 Dry	34.41 36.44	51.31 54.33	8.72 9.23	2.87 3.04	------ ------	12643 13386	------ 15324
12794	[9]B. M. 7	8/11	Saline	5	7.12 Dry	34.55 37.20	50.68 54.56	7.65 8.24	2.23 2.40	------ ------	12481 13439	------ 14835
12795	[9]B. M. 7	8/11	Saline	5	7.02 Dry	34.58 37.19	51.46 55.35	6.94 7.46	2.07 2.23	------ ------	12640 13594	------ 14862
28448	[10]B. M. 8	7/17	Saline	5	4.73 Dry	37.88 39.76	47.70 50.07	9.69 10.17	4.13 4.33	------ ------	12463 13081	------ 14844
28449	[10]B. M. 8	7/17	Saline	5	4.94 Dry	39.50 41.55	45.79 48.17	9.77 10.28	3.94 4.14	------ ------	12420 13066	------ 14840
1704	[11]B. M. 41	6/05	Sangamon	5	13.89 Dry	33.96 39.43	40.89 47.49	11.26 13.08	3.83 4.45	------ ------	10636 12352	------ 14543
1705	[11]B. M. 41	6/05	Sangamon	5	14.45 Dry	34.79 40.67	40.10 46.87	10.66 12.46	3.46 4.04	------ ------	------- -------	------ ------
1740	[11]B. M. 41	6/05	Sangamon	5	12.77 Dry	34.68 39.76	40.77 46.74	11.78 13.50	4.16 4.77	------ ------	10757 12332	------ 13395
5118	36	7/12	Sangamon	5	16.05 Dry	35.82 42.66	37.14 44.25	10.99 13.09	3.55 4.22	.67 .80	10330 12306	------ 14476
5119	36	7/12	Sangamon	5	15.53 Dry	36.36 43.04	38.05 45.05	10.06 11.91	3.86 4.57	.55 .66	10522 12457	------ 14450
5120	36	7/12	Sangamon	5	14.45 Dry	37.46 43.79	38.27 44.73	9.82 11.48	3.59 4.19	.55 .65	10704 12512	------ 14423
5128	37	7/12	Sangamon	5	14.08 Dry	37.38 43.51	37.56 43.71	10.98 12.78	3.97 5.17	.38 .49	9471 12337	------ 14492
5129	37	7/12	Sangamon	5	13.86 Dry	37.11 43.08	39.05 45.34	9.98 11.58	2.57 4.07	.52 .61	10726 12451	------ 14365
5166	39	7/12	Sangamon	5	13.38 Dry	37.20 42.95	36.40 42.03	13.01 15.02	4.78 5.52	.96 1.10	10338 11934	------ 14439
5167	39	7/12	Sangamon	5	13.35 Dry	36.64 42.27	37.12 42.85	12.89 14.88	4.80 5.53	.84 .97	10348 11942	------ 14423
5168	39	7/12	Sangamon	5	13.19 Dry	38.44 44.28	36.47 42.00	11.90 13.72	4.61 5.31	1.05 1.20	10513 12110	------ 14397
5187	40	7/12	Sangamon	5	14.82 Dry	37.18 43.65	38.22 44.87	9.78 11.48	4.30 4.52	.72 .84	10683 12541	------ 14483
5188	40	7/12	Sangamon	5	16.05 Dry	35.58 42.38	38.04 45.32	10.33 12.30	4.18 4.98	.17 .20	10413 12404	------ 14476
5189	40	7/12	Sangamon	5	14.31 Dry	37.31 43.54	38.20 44.58	10.18 11.88	4.21 4.91	.90 1.05	10655 12434	------ 14251
5196	38	7/12	Sangamon	5	14.25 Dry	37.25 43.44	37.07 43.24	11.43 13.32	4.76 5.55	.98 1.15	10414 12147	------ 14381
5197	38	7/12	Sangamon	5	14.10 Dry	38.74 45.09	37.66 43.85	9.50 11.06	3.86 4.50	.75 .87	10790 12564	------ 14415

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[9] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 85, p. 37, 1914.

[10] U. S. Bureau of Mines, unpublished analyses.

[11] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 91, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5198	38	7/12	Sangamon	5	14.44	38.22	37.68	9.66	3.79	.63	10746	------
					Dry	44.67	44.04	11.29	4.43	.73	12549	14435
5199	38	7/12	Sangamon	5	14.08	38.05	35.30	12.57	5.87	.60	10228	------
					Dry	44.28	41.09	14.63	6.83	.69	11903	14366
81448	119	9/21	Sangamon	5	13.79	34.86	39.58	11.77	3.88	.58	10576	------
					Dry	40.44	45.91	13.65	4.50	.67	12268	14546
81449	119	9/21	Sangamon	5	14.78	35.20	39.74	10.28	3.72	.33	10606	------
					Dry	41.30	46.64	12.06	4.37	.39	12445	14454
81450	119	9/21	Sangamon	5	13.62	37.50	39.30	9.58	3.62	.39	10876	------
					Dry	43.41	45.50	11.09	4.06	.45	12591	14439
81452	120	9/21	Sangamon	5	13.19	36.95	41.18	8.68	3.65	.44	11120	------
					Dry	42.56	47.44	10.00	4.20	.51	12810	14381
81453	120	9/21	Sangamon	5	13.75	37.20	37.60	11.45	4.38	1.09	10567	------
					Dry	43.13	43.59	13.28	5.08	1.26	12252	14478
81454	120	9/21	Sangamon	5	13.94	36.29	38.94	10.83	3.76	.85	10672	------
					Dry	42.17	45.25	12.58	4.37	.99	12401	14499
81456	121	9/21	Sangamon	5	13.26	34.27	41.93	10.54	3.71	.16	10824	------
					Dry	39.51	48.34	12.15	4.28	.18	12479	14509
81457	121	9/21	Sangamon	5	14.14	35.08	40.61	10.17	3.87	.67	10709	------
					Dry	40.86	47.30	11.84	4.51	.78	12473	14453
81458	121	9/21	Sangamon	5	14.79	34.30	40.77	10.14	3.68	.53	10691	------
					Dry	40.25	47.85	11.90	4.32	.62	12547	14544
81440	122	9/21	Sangamon	5	13.09	36.51	41.14	9.26	3.77	.70	10935	------
					Dry	42.01	47.34	10.65	4.34	.81	12582	14609
81441	122	9/21	Sangamon	5	12.76	35.36	41.92	9.96	3.98	.82	10907	------
					Dry	40.53	48.05	11.42	4.56	.94	12502	14411
81442	122	9/21	Sangamon	5	13.62	35.00	40.80	10.58	3.95	.35	10594	------
					Dry	40.52	47.23	12.25	4.57	.41	12264	14282
81311	217	9/21	Shelby	5	12.10	35.78	40.71	11.41	3.46	.78	10807	------
					Dry	40.71	46.31	12.98	3.94	.89	12295	14506
81312	217	9/21	Shelby	5	10.42	36.85	42.83	9.90	3.48	.23	11335	------
					Dry	41.14	47.81	11.05	3.88	.26	12653	14499
81313	217	9/21	Shelby	5	10.71	37.16	40.91	11.22	4.16	.57	11009	------
					Dry	41.62	45.81	12.57	4.66	.64	12330	14701
5277	27	7/12	Tazewell	5	14.71	37.46	38.57	10.26	3.51	1.15	10801	------
					Dry	44.06	44.03	11.91	4.07	1.33	12516	14500
5278	27	7/12	Tazewell	5	13.88	37.58	40.01	8.53	2.55	.95	11076	------
					Dry	43.64	46.45	9.91	2.96	1.10	12860	14499
5281	27	8/12	Tazewell	5	15.56	37.60	36.70	10.14	3.23	1.50	10552	------
					Dry	44.53	43.46	12.01	3.83	1.78	12496	14488
84483	108	3/22	Tazewell	5	15.4	35.1	40.4	9.1	2.6	1.26	10720	------
					Dry	41.5	47.8	10.7	3.0	1.49	12670	14261
84484	108	3/22	Tazewell	5	16.5	32.8	41.6	9.1	3.1	.57	10590	------
					Dry	39.3	49.8	10.9	3.7	.68	12690	14508
84485	108	3/22	Tazewell	5	15.4	35.2	39.8	9.6	4.2	.42	10670	------
					Dry	41.6	47.1	11.3	5.0	.50	12610	15524

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
					No. 6 Coal.							
80788	218	8/21	Bond	6	11.69	34.15	43.22	10.94	3.55	.80	10784	------
					Dry	38.67	48.94	12.39	4.02	.91	12212	14229
80789	218	8/21	Bond	6	12.55	35.58	41.60	10.27	3.51	.41	10745	------
					Dry	40.69	47.57	11.74	4.01	.47	12287	14199
80790	218	8/21	Bond	6	11.64	35.55	42.12	10.69	3.09	.79	10890	------
					Dry	40.23	47.67	12.10	3.50	.89	12325	14294
81315	219	9/21	Christian	6	11.96	36.12	42.08	9.84	3.31	.21	10989	------
					Dry	41.03	47.79	11.18	3.76	.24	12482	14318
81316	219	9/21	Christian	6	11.74	37.52	37.67	13.07	5.23	.39	10482	------
					Dry	42.51	42.68	14.81	5.93	.44	11876	14706
81317	219	9/21	Christian	6	12.30	38.02	39.56	10.12	3.03	.76	10924	------
					Dry	43.35	45.11	11.54	3.45	.87	12456	14343
81444	220	9/21	Christian	6	13.34	36.44	39.03	11.19	3.63	.77	10679	------
					Dry	42.05	45.04	12.91	4.19	.89	12323	14382
81445	220	9/21	Christian	6	13.67	35.65	39.60	11.08	4.17	.57	10622	------
					Dry	41.30	45.87	12.83	4.83	.66	12304	14448
81446	220	9/21	Christian	6	14.74	37.10	39.34	8.82	4.20	.30	10745	------
					Dry	43.51	46.15	10.34	4.93	.35	12603	14649
81138	221	8/21	Christian	6	11.12	37.81	41.16	9.91	4.15	.17	11070	------
					Dry	42.54	46.31	11.15	4.67	.19	12455	14311
81139	221	8/21	Christian	6	12.21	37.30	40.87	9.62	4.08	.05	10951	------
					Dry	42.49	46.55	10.96	4.65	.06	12474	14299
81140	221	8/21	Christian	6	12.81	36.18	39.79	11.22	4.28	.46	10642	------
					Dry	41.50	45.63	12.87	4.91	.53	12206	14340
81142	222	8/21	Christian	6	12.27	37.17	40.67	9.89	3.49	.08	10917	------
					Dry	42.37	46.36	11.27	3.98	.09	12444	14298
81143	222	8/21	Christian	6	11.75	37.46	41.33	9.46	4.38	.23	11089	------
					Dry	42.45	46.83	10.72	4.96	.26	12565	14372
81144	222	8/21	Christian	6	12.31	38.31	41.22	8.16	3.27	.04	11124	------
					Dry	43.69	47.00	9.31	3.73	.05	12686	13083
25748	[12]B. M. 56	9/16	Christian	6	13.62	37.60	39.62	9.16	3.78	------	11020	------
					Dry	43.53	45.87	10.60	4.38	------	12757	14553
25749	[12]B. M. 56	9/16	Christian	6	13.72	37.42	39.05	9.81	4.11	------	10847	------
					Dry	43.37	45.26	11.37	4.76	------	12571	14490
25750	[12]B. M. 56	9/16	Christian	6	12.52	34.74	39.06	13.68	3.40	------	10386	------
					Dry	39.71	44.65	15.64	3.89	------	11873	14245
25751	[12]B. M. 56	9/16	Christian	6	12.31	38.59	39.15	9.95	3.54	------	11086	------
					Dry	44.00	44.65	11.35	4.04	------	12641	14544
26336	[12]B. M. 56	11/16	Christian	6	11.89	37.14	40.58	10.39	3.88	------	11056	------
					Dry	42.15	46.06	11.79	4.40	------	12548	14529
26337	[12]B. M. 56	11/16	Christian	6	11.98	38.52	39.18	10.32	4.21	------	11120	------
					Dry	43.76	44.72	11.72	4.78	------	12634	14293

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[12] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 193, p. 30, 1922.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5052	85	8/12	Clinton	6	12.60 Dry	36.78 42.07	40.48 46.32	10.14 11.61	2.88 3.29	.77 .88	10827 12388	------ 14269
5053	85	7/12	Clinton	6	12.15 Dry	37.74 42.96	40.52 46.13	9.59 10.91	3.51 3.99	.29 .33	10949 12464	------ 14256
5054	85	7/12	Clinton	6	12.43 Dry	37.23 41.28	39.93 46.84	10.41 11.88	4.19 4.79	.38 .44	10730 12253	------ 14211
5073	84	7/12	Clinton	6	13.32 Dry	37.43 43.18	39.02 45.02	10.23 11.80	4.06 4.68	.69 .80	10726 12374	------ 14336
5074	84	7/12	Clinton	6	12.40 Dry	37.94 43.32	39.04 44.56	10.62 12.12	4.24 4.84	.58 .69	10796 12323	------ 14380
80744	198	8/21	Clinton	6	11.78 Dry	36.43 41.29	40.93 46.40	10.86 12.31	4.22 4.78	.63 .71	10771 12209	------ 14234
80745	198	8/21	Clinton	6	11.40 Dry	36.59 41.30	41.07 46.35	10.94 12.35	3.74 4.22	.62 .70	10817 12209	------ 14887
80746	198	8/21	Clinton	6	10.11 Dry	37.97 42.24	41.14 45.77	10.78 11.99	2.58 2.87	.60 .67	11064 12308	------ 14231
80767	199	8/21	Clinton	6	10.52 Dry	34.59 38.66	43.42 48.52	11.47 12.82	3.80 4.25	.35 .39	10953 12241	------ 13151
80768	199	8/21	Clinton	6	11.73 Dry	35.25 39.93	43.87 49.70	9.15 10.37	3.48 3.94	.22 .25	11034 12500	------ 14201
80769	199	8/21	Clinton	6	11.26 Dry	34.94 39.38	42.49 47.87	11.31 12.75	3.46 3.90	.77 .87	10774 12141	------ 14207
2856	[13]B. M. 46	2/06	Clinton	6	11.64 Dry	35.41 40.07	44.29 50.13	8.66 9.80	3.41 3.86	------ ------	11290 12776	------ 14415
2857	[13]B. M. 46	2/06	Clinton	6	12.15 Dry	35.60 40.52	42.97 48.92	9.28 10.56	4.01 4.56	------ ------	------ ------	------ ------
2991	[13]B. M. 46	2/06	Clinton	6	11.35 Dry	34.62 39.05	40.63 45.83	13.40 15.12	4.76 5.37	------ ------	10733 12107	------ 14312
2854	[13]B. M. 47	2/06	Clinton	6	13.43 Dry	33.02 38.14	44.37 51.26	9.18 10.60	3.35 3.87	------ ------	10937 12634	------ 14619
2855	[13]B. M. 47	2/06	Clinton	6	12.73 Dry	33.35 38.21	44.32 50.79	9.60 11.00	3.60 4.13	------ ------	------ ------	------ ------
2972	[13]B. M. 47	2/06	Clinton	6	11.44 Dry	33.93 38.31	43.92 49.60	10.71 13.09	4.94 5.58	------ ------	10958 12373	------ 14983
4384	[13]B. M. 48	1/07	Clinton	6	14.45 Dry	29.76 34.79	46.16 53.95	9.63 11.26	2.09 2.44	------ ------	------ ------	------ ------
4385	[13]B. M. 48	1/07	Clinton	6	15.06 Dry	29.48 34.71	45.81 53.93	9.65 11.36	1.05 1.24	------ ------	10726 12629	------ 14447
4785	53	4/12	Franklin	6	10.57 Dry	33.37 37.30	43.09 48.19	12.97 14.51	.83 .93	4.38 4.89	10714 11980	------ 14236
4786	53	4/12	Franklin	6	10.00 Dry	32.80 36.45	50.92 56.59	6.27 6.96	.66 .73	.33 .36	12001 13334	------ 14453
4787	53	4/12	Franklin	6	10.15 Dry	32.88 36.59	50.56 56.27	6.41 7.14	.59 .65	.22 .25	12000 13356	------ 14494

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[13] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 83, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
4789	53	4/12	Franklin	6	10.00	32.08	50.93	6.98	.47	.17	11935	----
					Dry	35.65	56.60	7.75	.52	.20	13261	14492
4791	58	4/12	Franklin	6	8.70	34.62	48.92	7.76	.62	.31	11945	------
					Dry	37.92	53.59	8.49	.68	.34	13084	14426
4793	58	4/12	Franklin	6	9.04	34.46	48.73	7.77	.68	.23	11946	------
					Dry	37.88	53.59	8.53	.74	.25	13133	14490
4794	58	4/12	Franklin	6	9.05	34.45	48.75	7.75	.91	.37	11923	------
					Dry	37.88	53.59	8.53	1.00	.41	13108	14472
4810	52	4/12	Franklin	6	6.96	38.42	44.16	10.46	2.98	.92	11848	------
					Dry	41.29	47.47	11.24	3.21	.99	12733	14568
4811	52	4/12	Franklin	6	7.34	38.11	44.23	10.32	3.26	1.41	11771	------
					Dry	41.13	47.73	11.14	3.51	1.53	12703	14561
4812	52	4/12	Franklin	6	6.00	38.55	45.46	9.99	3.16	1.20	11998	------
					Dry	41.01	48.36	10.63	3.36	1.28	12776	14534
5008	51	6/12	Franklin	6	10.63	33.23	48.79	7.35	1.40	.38	11800	------
					Dry	37.18	54.59	8.23	1.19	.43	13207	14534
5009	51	6/12	Franklin	6	9.83	33.91	49.14	7.12	1.13	.18	11942	------
					Dry	37.62	54.48	7.90	1.25	.20	13245	14522
5011	51	6/12	Franklin	6	10.39	33.13	49.23	7.25	1.37	.06	11920	------
					Dry	36.97	54.93	8.10	1.53	.06	13303	14629
5208	56	7/12	Franklin	6	6.43	37.62	44.77	11.18	2.64	.64	11834	------
					Dry	40.20	47.85	11.95	2.82	.68	12646	14620
5209	56	7/12	Franklin	6	10.15	35.55	45.82	8.48	1.41	.80	11691	------
					Dry	39.56	51.01	9.43	1.57	.89	13011	14539
5211	56	7/12	Franklin	6	7.71	35.75	45.38	11.16	3.50	.89	11644	------
					Dry	38.74	49.17	12.09	3.79	.96	12616	14644
5222	50	7/12	Franklin	6	9.66	34.55	47.85	7.95	1.04	.31	11916	------
					Dry	38.24	52.97	8.79	1.15	.34	13190	14613
5223	50	7/12	Franklin	6	9.00	35.10	47.35	8.55	1.08	.40	11973	------
					Dry	38.58	53.03	9.39	1.19	.44	13159	14684
5224	50	7/12	Franklin	6	9.36	34.86	48.90	6.88	1.01	.43	12122	------
					Dry	38.46	53.96	7.58	1.12	.48	13373	14603
5507	57	8/12	Franklin	6	9.83	31.82	49.78	8.57	.79	.35	11702	------
					Dry	35.28	55.22	9.50	.88	.39	12977	14490
5508	57	8/12	Franklin	6	9.44	32.57	50.09	7.90	.67	.29	11914	------
					Dry	35.97	55.31	8.72	.74	.32	13156	14547
5509	57	8/12	Franklin	6	9.75	32.33	48.77	9.15	1.39	.32	11652	------
					Dry	35.83	54.03	10.14	1.54	.35	12911	14550
12701	134	6/21	Franklin	6	8.88	32.17	50.84	8.11	.78	.11	11862	------
					Dry	35.31	55.80	8.89	.86	.12	13018	14428
12702	134	6/21	Franklin	6	7.11	34.23	48.83	9.83	1.30	.35	11883	------
					Dry	36.85	52.57	10.58	1.40	.37	12716	14483
12703	134	6/21	Franklin	6	8.31	34.07	49.44	8.18	1.02	.21	12010	------
					Dry	37.16	53.91	8.93	1.12	.23	13043	14534
12720	134	6/21	Franklin	6	9.24	32.39	49.49	8.88	1.50	.21	11722	------
					Dry	35.69	54.53	9.78	1.65	.23	12833	14496

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12721	134	6/21	Franklin	6	7.61	34.77	48.96	8.66	1.70	.05	12038	------
					Dry	37.63	53.00	9.37	1.85	.05	12937	14559
12722	134	6/21	Franklin	6	8.56	31.76	50.52	9.16	1.29	.32	11662	------
					Dry	34.73	55.26	10.01	1.41	.35	12683	14346
12729	136	6/21	Franklin	6	6.72	35.94	46.32	11.02	3.11	.72	11599	------
					Dry	38.53	49.65	11.82	3.33	.78	12268	14365
12730	136	6/21	Franklin	6	6.95	35.53	46.19	11.33	3.42	.51	11469	------
					Dry	38.18	49.65	12.17	3.68	.55	12444	14450
12731	136	6/21	Franklin	6	8.36	32.98	51.49	7.17	1.28	.26	12070	------
					Dry	35.99	56.19	7.82	1.40	.28	13100	14430
12732	136	6/21	Franklin	6	6.23	36.30	46.99	10.08	3.63	.39	11797	------
					Dry	38.88	50.32	10.80	3.89	.42	12440	14433
12733	136	6/21	Franklin	6	8.46	35.77	46.51	9.26	2.40	.15	11712	------
					Dry	39.08	50.80	10.12	2.73	.17	12607	14487
12734	136	6/21	Franklin	6	7.52	34.46	48.88	9.14	1.20	.22	11895	------
					Dry	37.26	52.86	9.88	1.30	.24	12797	14440
30892	137	9/18	Franklin	6	10.04	35.48	47.29	7.19	.77	------	11945	------
					Dry	39.44	52.57	7.99	.86	------	13279	14608
30893	137	9/18	Franklin	6	11.33	32.38	47.18	9.11	.59	------	11430	------
					Dry	36.52	53.21	10.27	.67	------	12892	14521
30894	137	9/18	Franklin	6	9.04	36.20	47.86	6.90	1.28	------	12164	------
					Dry	39.80	52.61	7.59	1.41	------	13374	14615
30895	137	9/18	Franklin	6	10.43	32.10	48.50	7.97	.52	------	11713	------
					Dry	36.95	54.15	8.90	.58	------	13075	14482
29741	138	2/18	Franklin	6	9.73	34.19	48.97	7.09	1.08	------	11997	------
					Dry	37.88	54.27	7.85	1.20	------	13289	14559
29742	138	2/18	Franklin	6	10.34	33.70	46.90	9.06	.54	------	11529	------
					Dry	37.59	52.31	10.10	.60	------	12857	14451
29743	138	2/18	Franklin	6	9.28	34.17	48.77	7.78	.74	------	11885	------
					Dry	37.67	53.75	8.58	.82	------	13100	14465
29744	138	2/18	Franklin	6	9.17	34.29	49.15	7.39	1.17	------	12163	------
					Dry	37.75	54.11	8.14	1.29	------	13390	14723
29745	138	2/18	Franklin	6	10.56	34.81	44.74	9.90	.45	------	11354	------
					Dry	38.92	50.01	11.07	.50	------	12695	14271
29746	138	2/18	Franklin	6	10.36	32.12	47.21	10.31	.56	------	11326	------
					Dry	35.83	52.67	11.50	.62	------	12634	14446
29754	138	2/18	Franklin	6	9.50	36.82	49.82	3.86	.79	------	12515	------
					Dry	40.69	55.04	4.27	.87	------	13829	13831
12682	139	6/21	Franklin	6	7.06	35.69	45.24	12.01	3.50	.33	11487	------
					Dry	38.41	48.67	12.92	3.77	.35	12171	14494
12683	139	6/21	Franklin	6	10.07	32.64	50.15	7.14	.76	.22	11850	------
					Dry	36.29	55.77	7.94	.85	.24	13177	14441
12684	139	6/21	Franklin	6	8.28	34.98	49.38	7.36	1.13	.25	12047	------
					Dry	38.14	53.84	8.02	1.24	.27	13072	14419
12698	139	6/21	Franklin	6	6.79	37.24	46.38	9.59	3.38	.31	11858	------
					Dry	39.96	49.76	10.28	3.63	.33	12541	14430

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12699	139	6/21	Franklin	6	8.07	33.85	49.71	8.37	1.02	.05	11908	------
					Dry	36.82	54.08	9.10	1.11	.05	12900	14420
12700	139	6/21	Franklin	6	6.96	36.53	44.79	11.72	3.95	.20	11590	------
					Dry	39.27	48.13	12.60	4.24	.22	12245	14567
12738	140	6/21	Franklin	6	5.74	36.04	48.19	10.03	3.37	.36	11960	------
					Dry	38.23	51.13	10.64	3.57	.38	12509	14453
12739	140	6/21	Franklin	6	6.64	36.34	48.38	8.64	2.75	.05	12043	------
					Dry	38.92	51.83	9.25	2.94	.05	12753	14444
12740	140	6/21	Franklin	6	8.15	32.79	51.10	7.96	1.51	.14	11890	------
					Dry	35.70	55.63	8.67	1.64	.16	12863	14337
30882	141	10/18	Franklin	6	9.94	33.39	48.99	7.68	1.14	------	11880	------
					Dry	37.08	54.39	8.53	1.27	------	13192	14571
30883	141	10/18	Franklin	6	10.04	33.08	49.42	7.46	1.24	------	11898	------
					Dry	36.77	54.94	8.29	1.38	------	13226	14677
30884	141	10/18	Franklin	6	10.73	33.02	47.65	8.60	1.61	------	11637	------
					Dry	36.99	53.38	9.63	1.80	------	13036	14609
30885	141	10/18	Franklin	6	10.05	33.93	48.58	7.44	1.40	------	11884	------
					Dry	37.72	54.01	8.27	1.56	------	13210	14674
23442	142	12/15	Franklin	6	9.72	32.91	48.92	8.45	.87	------	11866	------
					Dry	36.45	54.19	9.36	.96	------	13144	14653
23443	142	12/15	Franklin	6	10.24	32.54	49.49	7.73	.80	------	11941	------
					Dry	36.25	55.14	8.61	.89	------	13304	14697
30887	143	10/18	Franklin	6	11.15	33.95	47.50	7.40	1.36	------	11734	------
					Dry	38.21	53.46	8.33	1.53	------	13207	14681
30888	143	10/18	Franklin	6	9.08	34.99	48.21	7.72	1.43	------	12019	------
					Dry	38.49	53.02	8.49	1.57	------	13219	14723
30889	143	10/18	Franklin	6	10.31	33.54	49.91	6.24	1.11	------	12055	------
					Dry	37.40	55.64	6.96	1.24	------	13441	14574
30867	144	9/18	Franklin	6	10.74	32.20	50.91	6.15	.83	------	12001	------
					Dry	36.07	57.04	6.89	.93	------	13444	14555
30868	144	9/18	Franklin	6	10.36	32.52	47.17	9.95	.63	------	11356	------
					Dry	36.28	52.62	11.10	.70	------	12668	14416
30869	144	9/18	Franklin	6	9.86	32.38	49.68	8.08	.93	------	11925	------
					Dry	35.92	55.12	8.96	1.03	------	13230	14682
30870	144	9/18	Franklin	6	10.91	32.32	50.89	5.88	.56	------	12049	------
					Dry	36.28	57.12	6.60	.63	------	13525	14548
12865	145	7/21	Franklin	6	8.33	31.23	51.35	9.09	1.24	.25	11846	------
					Dry	34.07	56.02	9.91	1.35	.27	12859	14512
12866	145	7/21	Franklin	6	8.17	32.54	50.60	8.69	1.20	.15	11942	------
					Dry	35.43	55.11	9.46	1.31	.17	12945	14525
12867	145	7/21	Franklin	6	8.96	32.71	50.71	7.62	.67	.08	11964	------
					Dry	35.93	55.70	8.37	.74	.08	13104	14472
20080	146	11/14	Franklin	6	9.33	31.15	50.36	9.16	.56	------	11806	------
					Dry	34.36	55.54	10.10	.62	------	13021	14636
20081	146	11/14	Franklin	6	10.01	29.93	50.08	9.98	.52	------	11522	------
					Dry	33.26	55.65	11.09	.58	------	12803	14564

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
20082	146	11/14	Franklin-------	6	9.25	31.03	51.02	8.70	.48	------	11857	------
					Dry	34.19	56.22	9.59	.53	------	13064	14478
20723	146	1/15	Franklin-------	6	8.21	32.46	49.00	10.33	.96	------	11770	------
					Dry	35.36	53.39	11.25	1.05	------	12823	14525
20724	146	1/15	Franklin-------	6	9.07	32.24	48.42	10.27	1.14	------	11606	------
					Dry	35.45	53.26	11.29	1.25	------	12764	14578
20725	146	1/15	Franklin-------	6	9.83	31.44	51.53	7.20	.50	------	11990	------
					Dry	34.87	57.15	7.98	.55	------	13297	14568
30877	147	10/18	Franklin-------	6	8.72	34.31	46.15	10.82	3.81	------	11543	------
					Dry	37.59	50.56	11.85	4.17	------	12645	14645
30878	147	9/18	Franklin-------	6	10.04	33.77	47.53	8.66	2.43	------	11725	------
					Dry	37.54	52.83	9.63	2.70	------	13034	14791
30879	147	10/18	Franklin-------	6	9.67	33.32	46.67	10.34	3.07	------	11547	------
					Dry	36.89	51.66	11.45	3.40	------	12784	14485
30880	147	10/18	Franklin-------	6	9.27	34.27	45.48	10.98	3.79	------	11461	------
					Dry	37.77	50.13	12.10	4.18	------	12632	14677
1695	[14]B. M. 9	/05	Franklin-------	6	10.28	32.04	49.74	7.94	1.06	------	-------	------
					Dry	35.71	55.44	8.85	1.18	------	-------	------
1694	[14]B. M. 9	/05	Franklin-------	6	9.46	33.55	48.87	8.12	1.63	------	11990	------
					Dry	37.06	53.97	8.97	1.80	------	13243	14725
1786	[14]B. M. 9	/05	Franklin-------	6	8.31	31.65	49.56	10.48	1.55	------	11727	------
					Dry	34.52	54.05	11.43	1.69	------	12789	14647
477D	[14]B. M. 10	8/08	Franklin-------	6	9.15	34.98	47.27	8.60	.99	------	-------	------
					Dry	38.50	52.03	9.47	1.09	------	-------	------
478D	[14]B. M. 10	8/08	Franklin-------	6	8.59	32.15	51.03	8.23	1.29	------	12114	------
					Dry	35.17	55.83	9.00	1.41	------	13253	14728
486D	[14]B. M. 10	8/08	Franklin-------	6	8.12	34.46	48.79	8.63	1.13	------	12064	------
					Dry	37.51	53.10	9.39	1.23	------	13131	14654
495D	[14]B. M. 10	8/08	Franklin-------	6	8.61	33.19	46.82	11.38	.95	------	11585	------
					Dry	36.32	51.23	12.45	1.04	------	12676	14682
1648	[15]B. M. 11	8/08	Franklin-------	6	9.50	31.98	47.08	11.44	1.45	------	11506	------
					Dry	35.34	52.02	12.64	1.60	------	12713	14780
1871	[15]B. M. 12	7/06	Franklin-------	6	9.90	28.67	53.69	7.74	.48	------	12001	------
					Dry	31.82	59.59	8.59	.53	------	13320	14700
1872	[15]B. M. 12	7/06	Franklin-------	6	10.53	29.06	53.01	7.40	.47	------	-------	------
					Dry	32.48	59.25	8.27	.53	------	-------	------
3408	[15]B. M. 12	7/06	Franklin-------	6	9.65	30.87	53.23	6.25	.45	------	-------	------
					Dry	34.17	58.91	6.92	.50	------	-------	------
1926	[15]B. M. 12	7/06	Franklin-------	6	14.91	26.66	49.50	8.93	.52	------	10958	------
					Dry	31.33	58.18	10.49	.61	------	12879	14545
2020	[15]B. M. 12	7/06	Franklin-------	6	10.72	29.86	50.06	9.36	.91	------	11686	------
					Dry	33.45	56.07	10.48	1.02	------	13088	14794
3447	[15]B. M. 12	7/06	Franklin-------	6	9.58	29.18	50.24	11.00	.52	------	11428	------
					Dry	32.27	55.56	12.17	.58	------	12632	14561

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[14] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 83, 1913.
[15] Ibid., p. 84.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
3448	[15]B. M. 12	7/06	Franklin-------	6	9.45	29.49	51.99	9.07	.60	------	11695	------
					Dry	32.57	57.41	10.02	.66	------	12915	14503
3451	[15]B. M. 12	7/06	Franklin-------	6	8.30	30.23	50.90	10.57	.52	------	11543	------
					Dry	32.97	55.50	11.53	.57	------	12587	14394
5214	[15]B. M. 12	7/06	Franklin-------	6	11.82	27.66	55.10	5.42	.46	------	11961	------
					Dry	31.37	62.47	6.16	.52	------	13565	14547
5237	[15]B. M. 12	7/06	Franklin-------	6	11.50	26.70	52.67	9.13	.60	------	11410	------
					Dry	30.17	59.51	10.32	.68	------	12893	14531
23473	[16]B. M. 13	11/15	Franklin-------	6	9.28	34.21	47.76	8.75	1.10	------	11950	------
					Dry	37.71	52.64	9.65	1.21	------	13172	14745
23474	[16]B. M. 13	11/15	Franklin-------	6	8.91	35.51	47.46	8.12	.80	------	12083	------
					Dry	38.98	52.11	8.91	.88	------	13266	14707
23475	[16]B. M. 13	11/15	Franklin-------	6	8.82	33.91	48.87	8.40	.81	------	12038	------
					Dry	37.19	53.60	9.21	.89	------	13203	14691
23476	[16]B. M. 13	11/15	Franklin-------	6	9.25	33.76	48.08	8.91	1.07	------	11898	------
					Dry	37.20	52.98	9.82	1.18	------	13111	14706
23477	[16]B. M. 13	11/15	Franklin-------	6	8.75	33.71	48.44	9.10	1.55	------	11943	------
					Dry	36.94	53.09	9.97	1.70	------	13088	14725
23478	[16]B. M. 13	11/15	Franklin-------	6	9.01	34.52	47.87	8.60	1.08	------	11970	------
					Dry	37.94	52.61	9.45	1.19	------	13154	14675
22686	[16]B. M. 14	7/15	Franklin-------	6	9.33	33.60	48.48	8.59	.82	------	11824	------
					Dry	37.06	53.47	9.47	.90	------	13041	14556
22687	[16]B. M. 14	7/15	Franklin-------	6	9.05	33.74	48.65	8.56	.96	------	11858	------
					Dry	37.10	53.49	9.41	1.06	------	13039	14548
22688	[16]B. M. 14	7/15	Franklin-------	6	8.59	34.66	48.89	7.86	.92	------	12089	------
					Dry	37.92	53.48	8.60	1.01	------	13225	14612
22689	[16]B. M. 14	7/15	Franklin-------	6	8.91	33.87	49.21	8.01	.99	------	12017	------
					Dry	37.18	54.03	8.79	7.09	------	13192	14610
22690	[16]B. M. 14	7/15	Franklin-------	6	10.06	33.92	47.26	8.76	.92	------	11756	------
					Dry	37.72	52.54	9.74	1.02	------	13072	14775
22691	[16]B. M. 14	7/15	Franklin-------	6	9.19	33.80	48.61	8.40	.92	------	11925	------
					Dry	37.22	53.53	9.25	1.01	------	13131	14622
23442	[16]B. M. 15	11/15	Franklin-------	6	9.72	32.91	48.92	8.45	.87	------	11866	------
					Dry	36.45	54.19	9.36	.96	------	13144	14653
23443	[16]B. M. 15	11/15	Franklin-------	6	10.24	32.54	49.49	7.73	.80	------	11941	------
					Dry	36.25	55.14	8.61	.89	------	13304	14697
23444	[16]B. M. 15	11/15	Franklin-------	6	9.93	33.13	48.77	8.17	.75	------	11896	------
					Dry	36.78	54.15	9.07	.83	------	13207	14668
20080	[16]B. M. 16	11/14	Franklin-------	6	9.33	31.15	50.36	9.16	.56	------	11806	------
					Dry	34.36	55.54	10.10	.62	------	13021	14636
20081	[16]B. M. 16	11/14	Franklin-------	6	10.01	29.93	50.08	9.98	.52	------	11522	------
					Dry	33.26	55.65	11.09	.58	------	12803	14564
20082	[16]B. M. 16	11/14	Franklin-------	6	9.25	31.03	51.02	8.70	.48	------	11857	------
					Dry	34.19	56.22	9.59	.53	------	13064	14606

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[16] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 33, 1918.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
20083	[16]B. M. 16	11/14	Franklin-------	6	9.61	30.68	50.44	9.27	.50	------	11725	------
					Dry	33.94	55.80	10.26	.55	------	12971	14604
20723	[16]B. M. 17	11/14	Franklin-------	6	8.21	32.46	49.00	10.33	.96	------	11770	------
					Dry	35.36	53.39	11.25	1.05	------	12823	14632
20724	[16]B. M. 17	11/14	Franklin-------	6	9.07	32.24	48.42	10.27	1.14	------	11606	------
					Dry	35.45	53.26	11.29	1.25	------	12764	14578
20725	[16]B. M. 17	11/14	Franklin-------	6	9.83	31.44	51.53	7.20	.50	------	11990	------
					Dry	34.87	57.15	7.98	.55	------	13297	14568
20726	[16]B. M. 17	11/14	Franklin-------	6	8.87	32.72	49.05	9.36	.94	------	11785	------
					Dry	35.90	53.83	10.27	1.03	------	12931	14915
22915	[16]B. M. 18	8/15	Franklin-------	6	9.78	32.29	49.73	8.20	1.02	------	11860	------
					Dry	35.79	55.12	9.09	1.13	------	13145	14613
22916	[16]B. M. 18	8/15	Franklin-------	6	10.23	31.97	49.87	7.93	.91	------	11839	------
					Dry	35.61	55.56	8.83	1.01	------	13189	14613
22917	[16]B. M. 18	8/15	Franklin-------	6	10.48	33.53	49.02	6.97	1.22	------	11932	------
					Dry	37.46	54.75	7.79	1.36	------	13329	14598
22918	[16]B. M. 18	8/15	Franklin-------	6	8.86	33.27	49.48	8.39	.86	------	11970	------
					Dry	36.50	54.29	9.21	.94	------	13133	14614
22919	[17]B. M. 19	8/15	Franklin-------	6	10.48	31.87	49.10	8.55	1.16	------	11678	------
					Dry	35.60	54.85	9.55	1.30	------	13046	14590
22920	[17]B. M. 19	8/15	Franklin-------	6	10.16	32.66	49.63	7.56	.99	------	11921	------
					Dry	36.35	55.23	8.42	1.10	------	13270	14634
22921	[17]B. M. 19	8/15	Franklin-------	6	9.99	32.82	49.27	7.92	1.03	------	11857	------
					Dry	36.46	54.74	8.80	1.14	------	13172	14593
26129	[18]B. M. 58	10/16	Franklin-------	6	10.61	33.39	48.37	7.63	1.02	------	11855	------
					Dry	37.35	54.11	8.54	1.14	------	13262	14646
30266	[18]B. M. 58	5/18	Franklin-------	6	7.86	34.10	49.62	8.42	1.18	------	12141	------
					Dry	37.01	53.85	9.14	1.28	------	13176	14709
30267	[19]B. M. 58	4/18	Franklin-------	6	7.83	34.70	47.96	9.51	1.20	------	11963	------
					Dry	37.65	52.03	10.32	1.30	------	12980	14651
30844	[19]B. M. 58	8/18	Franklin-------	6	8.02	35.66	48.46	7.86	1.07	------	12128	------
					Dry	38.77	52.68	8.55	1.16	------	13187	14566
31050	[19]B. M. 58	10/18	Franklin-------	6	7.35	36.70	47.88	8.07	1.02	------	12164	------
					Dry	39.61	51.68	8.71	1.10	------	13129	14526
29741	[19]B. M. 21	3/18	Franklin-------	6	9.73	34.19	48.99	7.09	1.08	------	11997	------
					Dry	37.88	54.27	7.85	1.20	------	13289	14562
29742	[19]B. M. 21	3/18	Franklin-------	6	10.34	33.70	46.90	9.06	.54	------	11529	------
					Dry	37.59	52.31	10.10	.60	------	12857	14449
29743	[19]B. M. 21	3/18	Franklin-------	6	9.28	34.17	48.77	7.78	.74	------	11885	------
					Dry	37.67	53.75	8.58	.82	------	13100	14465
29744	[19]B. M. 21	3/18	Franklin-------	6	9.17	34.29	49.15	7.39	1.17	------	12163	------
					Dry	37.75	54.11	8.14	1.29	------	13390	14723

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[17] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 34, 1918.
[18] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 193, p. 30, 1922.
[19] Ibid., p. 31.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
29745	[19]B. M. 21	3/18	Franklin-------	6	10.56	34.81	44.73	9.90	.45	------	11354	------
					Dry	38.92	50.01	11.07	.50	------	12695	14433
29746	[19]B. M. 21	3/18	Franklin-------	6	10.36	32.12	47.21	10 31	.56	------	11326	------
					Dry	35.83	52.67	11.50	.62	------	12634	14446
29754	[19]B. M. 21	3/18	Franklin-------	6	9.50	36.82	49.82	3.86	.79	------	12515	------
					Dry	40.69	55.04	4.27	.87	------	13829	14524
30205	[20]B. M. 20	5/18	Franklin-------	6	7.64	31.37	50.03	10.96	1.06	------	11687	------
					Dry	33.96	54.17	11.87	1.15	------	12654	14554
30207	[20]B. M. 20	4/18	Franklin-------	6	8.86	31.23	49.28	10.63	1.10	------	11603	------
					Dry	34.27	54.07	11.66	1.21	------	12731	14606
26492	[20]B. M. 22	12/16	Franklin-------	6	9.54	32.91	48.41	9.14	.98	------	11772	------
					Dry	36.38	53.52	10.10	1.08	------	13014	14644
26493	[20]B. M. 22	12/16	Franklin-------	6	9.58	33.25	50.16	7.01	1.08	------	12051	------
					Dry	36.77	55.48	7.75	1.19	------	13329	14585
26494	[20]B. M. 22	12/16	Franklin-------	6	10.97	33.70	46.86	8.47	.99	------	11671	------
					Dry	37.85	52.64	9.51	1.11	------	13109	14812
26495	[20]B. M. 22	12/16	Franklin-------	6	10.26	33.17	48.39	8.18	1.31	------	11858	------
					Dry	36.96	53.93	9.11	1.46	------	13214	14705
26496	[20]B. M. 22	12/16	Franklin-------	6	9.68	32.90	48.35	9.07	1.09	------	11693	------
					Dry	36.43	53.53	10.04	1.21	------	12946	14260
30206	[20]B. M. 22	4/18	Franklin-------	6	8.49	34.11	48.71	8.69	1.11	------	12064	------
					Dry	37.28	53.22	9.50	1.21	------	13183	14731
30208	[20]B. M. 22	11/16	Franklin-------	6	8.05	34.51	47.67	9.77	1.06	------	11927	------
					Dry	37.53	51.85	10.62	1.15	------	12971	14635
30485	[20]B. M. 22	11/16	Franklin-------	6	9.66	34.06	47.27	9.01	1.17	------	11866	------
					Dry	37.70	52.33	9.97	1.30	------	13135	14650
30486	[20]B. M. 22	11/16	Franklin-------	6	10.04	33.61	48.01	8.34	1.10	------	11898	------
					Dry	37.36	53.37	9.27	1.22	------	13226	14739
5528	----------	8/12	Gallatin--------	6	10.82	33.83	42.43	12.92	4.93	.42	11263	------
					Dry	37.94	47.57	14.49	5.53	.47	11609	15193
5510	223	8/12	Gallatin--------	6	4.47	33.33	47.73	11.46	3.59	.05	12320	------
					Dry	36.98	49.96	13.06	3.76	.05	12895	15157
5511	223	8/12	Gallatin--------	6	4.10	36.79	50.38	8.73	3.83	.04	12849	------
					Dry	38.36	52.54	9.10	3.99	.04	13397	15001
5513	223	8/12	Gallatin--------	6	12.55	34.81	46.34	6.30	5.61	.01	12015	------
					Dry	39.81	52.98	7.21	6.41	.01	13739	15129
23426	[21]B. M. 57	11/15	Gallatin-------	6	3.70	37.72	49.17	9.41	3.03	------	12987	------
					Dry	39.17	51.06	9.77	3.15	------	13487	15375
4773	55	4/12	Jackson--------	6	10.88	31.71	48.90	8.51	.65	.30	11594	------
					Dry	35.57	54.88	9.55	.73	.34	13009	14531
4780	55	4/12	Jackson--------	6	7.17	36.36	45.25	11.22	3.92	.43	11678	------
					Dry	39.18	48.74	12.08	4.22	.47	12581	14617

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[20] Ibid., p. 32.

[21] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 34, 1918.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
4784	55	4/12	Jackson	6	8.82 Dry	35.30 38.72	44.96 49.30	10.92 11.98	3.46 3.79	.50 .54	11547 12663	------ 14676
12647	183	6/21	Jackson	6	10.34 Dry	35.71 39.82	45.74 51.02	8.21 9.16	1.03 1.15	.03 .03	11585 12920	------ 14376
12648	183	6/21	Jackson	6	10.00 Dry	32.81 36.46	47.33 52.58	9.86 10.96	1.27 1.41	.07 .08	11356 12618	------ 14357
12649	183	6/21	Jackson	6	9.16 Dry	34.31 37.77	46.76 53.00	9.77 10.33	1.24 1.36	.20 .22	11523 12684	------ 14317
12650	183	6/21	Jackson	6	9.86 Dry	33.70 37.38	45.30 50.26	11.14 12.36	2.04 2.26	.27 .30	11169 12391	------ 14377
12651	183	6/21	Jackson	6	9.46 Dry	35.05 38.71	46.85 51.75	8.64 9.54	1.75 1.93	.07 .07	11586 12796	------ 14326
12652	183	6/21	Jackson	6	9.66 Dry	35.94 39.78	45.96 50.87	8.44 9.35	1.28 1.42	.22 .24	11583 12751	------ 14307
2611	224	1/10	Livingston	6	16.50 Dry	32.63 39.07	45.50 54.49	5.37 6.44	1.60 1.92	------ ------	11297 13529	------ 14600
5086	66	7/12	Macoupin	6	4.29 Dry	39.09 45.60	37.21 43.42	9.41 10.98	4.13 4.82	.32 .37	10635 12408	------ 14234
5087	66	7/12	Macoupin	6	13.77 Dry	38.69 44.86	36.74 42.62	10.80 12.52	4.37 5.07	.62 .71	10493 12169	------ 14236
5088	66	7/12	Macoupin	6	14.73 Dry	38.33 44.95	37.24 43.69	9.70 11.36	4.50 5.28	.30 .35	10522 12339	------ 14237
5097	69	7/12	Macoupin	6	14.73 Dry	36.26 42.53	36.11 42.34	12.90 15.13	4.62 5.42	.28 .33	10099 11843	------ 14342
5098	69	7/12	Macoupin	6	13.68 Dry	38.02 44.05	37.72 43.70	10.58 12.25	4.43 5.12	.21 .25	10618 12300	------ 14346
5099	69	7/12	Macoupin	6	14.19 Dry	37.92 44.19	37.03 43.15	10.86 12.66	4.21 4.91	.39 .45	10599 12351	------ 14476
5100	67	7/12	Macoupin	6	15.12 Dry	38.28 45.09	36.55 43.06	10.05 11.85	3.85 4.54	.31 .37	10610 12501	------ 14488
5101	67	7/12	Macoupin	6	14.90 Dry	37.75 44.35	38.43 45.16	8.92 10.49	3.67 4.31	.45 .53	10735 12614	------ 14367
5102	67	7/12	Macoupin	6	14.67 Dry	35.49 41.59	38.83 45.50	11.01 12.91	4.15 4.86	.22 .26	10433 12227	------ 14370
5112	68	7/12	Macoupin	6	12.11 Dry	40.32 45.88	39.14 44.52	8.43 9.60	4.39 5.00	.38 .43	11170 12705	------ 14335
5113	68	7/12	Macoupin	6	13.27 Dry	38.58 44.48	38.15 43.99	10.00 11.53	4.89 5.64	.27 .31	10790 12442	------ 14400
5114	68	7/12	Macoupin	6	13.23 Dry	38.85 44.77	38.91 44.84	9.01 10.39	4.39 5.06	.28 .32	10935 12601	------ 14359
81323	185	9/21	Macoupin	6	13.32 Dry	37.97 43.80	39.84 45.97	8.87 10.23	3.40 3.92	.31 .36	10893 12567	------ 14252
81324	185	9/21	Macoupin	6	12.41 Dry	37.96 43.34	39.98 45.64	9.65 11.02	3.57 4.08	.29 .33	10889 12432	------ 14241
81325	185	9/21	Macoupin	6	9.84 Dry	42.13 46.73	39.51 43.82	8.52 9.45	3.51 3.89	.24 .27	11426 12673	------ 14237

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
81327	186	9/21	Macoupin------	6	11.18	37.54	40.19	11.09	3.65	1.00	10841	------
					Dry	42.27	45.24	12.49	4.11	1.13	12206	14243
81328	186	9/21	Macoupin------	6	9.01	39.20	41.42	10.37	4.32	.58	11193	------
					Dry	43.08	45.52	11.40	4.75	.64	12301	14177
81329	186	9/21	Macoupin------	6	13.17	36.72	40.09	10.02	4.04	.40	10685	------
					Dry	42.29	46.17	11.54	4.65	.46	12306	14206
81331	228	9/21	Macoupin------	6	14.03	37.17	39.60	9.20	3.49	------	10753	------
					Dry	43.24	46.06	10.70	4.06	------	12508	14273
81332	187	9/21	Macoupin------	6	13.30	37.46	38.68	10.56	4.23	.36	10621	------
					Dry	43.21	44.61	12.18	4.88	.42	12250	14264
81333	187	9/21	Macoupin------	6	13.52	36.25	38.70	11.53	4.38	.63	10471	------
					Dry	41.92	44.75	13.33	5.06	.73	12108	14314
81334	187	9/21	Macoupin------	6	13.86	36.52	39.11	10.51	3.97	.22	10554	------
					Dry	42.40	45.40	12.20	4.61	.26	12252	14261
81085	188	8/21	Macoupin------	6	12.30	38.69	41.07	7.94	3.62	.15	11080	------
					Dry	44.12	46.83	9.05	4.13	.17	12634	14127
81086	188	8/21	Macoupin------	6	11.39	39.03	40.49	9.09	4.57	.17	11037	------
					Dry	44.05	45.69	10.26	5.16	.19	12456	14170
81087	188	8/21	Macoupin------	6	12.24	38.25	41.24	8.27	3.61	.11	11066	------
					Dry	43.58	47.00	9.42	4.11	.13	12609	14163
81016	189	8/21	Macoupin------	6	12.74	36.09	42.77	8.40	3.73	.15	10948	------
					Dry	41.36	49.01	9.63	4.27	.17	12546	14134
81017	189	8/21	Macoupin------	6	15.67	33.57	41.53	9.23	3.56	.10	10379	------
					Dry	39.81	49.24	10.95	4.22	.12	12308	14090
81018	189	8/21	Macoupin------	6	13.40	35.71	41.83	9.06	4.06	.10	10711	------
					Dry	41.24	48.30	10.46	4.69	.12	12368	14087
81020	190	8/21	Macoupin------	6	13.92	34.44	43.00	8.64	3.79	.17	10814	------
					Dry	40.01	49.95	10.04	4.40	.20	12563	14229
81021	190	8/21	Macoupin------	6	13.26	34.81	42.29	9.64	3.90	.07	10773	------
					Dry	40.13	48.76	11.11	4.50	.08	12420	14257
81022	190	8/21	Macoupin------	6	15.16	33.46	41.97	9.41	3.21	.22	10540	------
					Dry	39.44	49.47	11.09	3.78	.26	12423	14235
1625	[22]B. M. 30	5/05	Macoupin------	6	13.29	37.07	40.74	8.90	4.12	------	11162	------
					Dry	42.75	46.99	10.26	4.75	------	12872	14637
1626	[22]B. M. 30	5/05	Macoupin------	6	15.27	36.19	39.34	9.20	3.70	------	------	------
					Dry	42.71	46.43	10.86	4.37	------	------	------
1635	[23]B. M. 30	5/05	Macoupin------	6	13.54	35.69	40.03	10.74	4.03	------	10807	------
					Dry	41.28	46.30	12.42	4.66	------	12499	14596
1639	[23]B. M. 30	5/05	Macoupin------	6	13.72	36.24	39.72	10.32	3.96	------	10870	------
					Dry	42.00	46.04	11.96	4.59	------	12598	14625
4247	[23]B. M. 30	5/05	Macoupin------	6	15.25	28.57	40.83	15.35	3.81	------	9790	------
					Dry	33.71	48.18	18.11	4.50	------	11551	14526
2731	[23]B. M. 30	5/05	Macoupin------	6	14.68	31.32	40.32	13.68	3.88	------	10053	------
					Dry	36.71	47.26	16.03	4.55	------	11782	14407

[22] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 85, 1913.
[23] Ibid., p. 86.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
18545	[24]B. M. 31	1/14	Macoupin------	6	12.90 Dry	37.80 43.40	39.77 45.66	9.53 10,94	4.23 4.86	------ ------	10852 12460	------ 14285
18546	[24]B. M. 31	1/14	Macoupin------	6	14.16 Dry	35.53 41.39	40.21 46.84	10.10 11.77	3.70 4.31	------ ------	10615 12366	------ 14306
18553	[24]B. M. 31	1/14	Macoupin------	6	13.59 Dry	37.20 43.05	39.33 45.52	9.88 11.43	3.86 4.47	------ ------	10701 12384	------ 14272
18910	[24]B. M. 31	1/14	Macoupin------	6	13.38 Dry	36.88 42.09	37.50 42.80	13.24 15.11	5.05 5.76	------ ------	10361 11825	------ 14329
5067	72	7/12	Madison-------	6	13.08 Dry	38.03 43.75	37.07 42.65	11.82 13.60	5.22 6.01	.25 .28	10543 12129	------ 14423
5068	72	7/12	Madison-------	6	13.53 Dry	37.26 43.84	40.98 45.53	8.23 10.63	3.81 4.37	.30 .23	10903 12587	------ 14363
5069	72	7/12	Madison-------	6	14.86 Dry	37.32 43.84	38.76 45.53	9.06 10.63	3.73 4.37	.20 .23	10717 12587	------ 14363
5070	71	7/12	Madison-------	6	12.99 Dry	37.73 43.36	36.89 42.40	12.39 14.24	4.43 5.09	.72 .82	10499 12066	------ 14440
5071	71	7/12	Madison-------	6	12.14 Dry	41.13 46.82	38.00 43.24	8.73 9.94	3.52 4.00	.41 .47	11206 12759	------ 14426
5072	71	7/12	Madison-------	6	12.42 Dry	39.82 45.46	37.65 43.00	10.11 11.54	4.35 4.96	.72 .80	10909 12456	------ 14398
5075	73	7/12	Madison-------	6	14.65 Dry	39.08 45.80	38.03 44.55	8.24 9.65	3.59 4.20	.29 .34	10865 12730	------ 14347
5076	73	7/12	Madison-------	6	14.31 Dry	38.35 44.75	38.32 44.72	9.02 10.53	3.77 4.40	.31 .37	10739 12532	------ 14283
5078	73	7/12	Madison-------	6	15.18 Dry	38.40 45.27	38.30 45.16	8.12 9.57	3.94 4.64	.23 .27	10751 12673	------ 14284
5515	70	8/12	Madison-------	6	13.88 Dry	37.60 43.65	37.74 43.82	10.78 12.53	4.21 4.89	.53 .61	10551 12250	------ 14330
5517	70	8/12	Madison-------	6	12.44 Dry	39.10 44.65	38.20 43.64	10.26 11.71	5.23 6.03	.64 .73	10818 12354	------ 14343
5518	70	8/12	Madison-------	6	12.11 Dry	39.32 44.74	36.27 41.26	12.30 14.00	4.92 5.60	.47 .53	10615 12076	------ 14421
80942	191	8/21	Madison-------	6	13.76 Dry	37.50 43.18	37.63 43.34	11.71 13.48	4.52 5.20	.45 .52	10556 12156	------ 14405
80943	191	8/21	Madison-------	6	13.76 Dry	39.10 45.34	37.39 43.35	9.75 11.31	2.89 3.35	.75 .87	10805 12529	------ 14382
80944	191	8/21	Madison-------	6	12.01 Dry	38.41 43.65	38.46 43.71	11.12 12.64	3.68 4.18	.33 .38	10763 12232	------ 14300
80862	192	8/21	Madison-------	6	11.71 Dry	37.44 42.41	40.57 45.95	10.28 11.64	4.32 4.89	.38 .43	10936 12386	------ 14327
80863	192	8/21	Madison-------	6	11.19 Dry	38.00 42.79	40.84 45.98	9.97 11.23	4.12 4.64	.47 .53	11066 12460	------ 14603
80864	192	8/21	Madison-------	6	12.02 Dry	35.62 40.49	41.79 47.50	10.57 12.01	3.69 4.19	.48 .55	10888 12376	------ 14604

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[24] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 34, 1918.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
1556	[25]B. M. 32	4/05	Madison-------	6	17.02	30.60	35.59	16.79	3.29	------	9319	------
					Dry	36.88	42.89	20.23	3.96	------	11230	14900
1608A	[25]B. M. 32	4/05	Madison-------	6	12.27	37.22	39.16	11.35	4.66	------	-------	------
					Dry	42.43	44.63	12.94	5.31	------	-------	------
1609	[25]B. M. 32	4/05	Madison-------	6	11.87	36.57	39.98	11.58	4.75	------	10768	------
					Dry	41.50	45.36	13.14	5.39	------	12218	14422
1611	[25]B. M. 32	4/05	Madison-------	6	11.46	34.98	36.25	17.31	4.40	------	10026	------
					Dry	39.51	40.94	19.55	4.97	------	11324	14541
1780	[25]B. M. 32	4/05	Madison-------	6	10.83	36.24	39.75	13.18	4.53	------	10816	------
					Dry	40.64	44.58	14.78	5.08	------	12130	14616
1722	[26]B. M. 33	4/05	Madison-------	6	10.69	33.08	36.14	20.09	4.06	------	9713	------
					Dry	37.04	40.47	22.49	4.55	------	10876	14560
2774	[26]B. M. 34	1/06	Madison-------	6	13.07	34.85	42.02	10.06	3.59	------	10949	------
					Dry	40.09	48.34	11.57	4.13	------	12596	14533
2775	[26]B. M. 34	1/06	Madison-------	6	12.79	35.67	40.25	11.29	3.94	------	-------	------
					Dry	40.90	46.15	12.95	4.52	------	-------	------
2819	[26]B. M. 34	1/06	Madison-------	6	13.47	34.35	40.65	11.53	4.41	------	10510	------
					Dry	39.70	46.98	13.32	5.10	------	12126	14331
2803	[26]B. M. 34	1/06	Madison-------	6	15.68	31.28	37.45	15.59	3.98	------	9655	------
					Dry	37.10	44.41	18.49	4.72	------	11450	14480
3911	[26]B. M. 35	10/06	Madison-------	6	14.25	35.52	40.79	9.44	3.72	------	10892	------
					Dry	41.42	47.57	11.01	4.34	------	12703	14564
3913	[26]B. M. 35	10/06	Madison-------	6	12.69	37.40	41.15	8.76	3.62	------	11236	------
					Dry	42.89	47.13	10.03	4.15	------	12868	14569
3963	[26]B. M. 35	10/06	Madison-------	6	13.10	30.78	40.12	16.00	4.17	------	9983	------
					Dry	35.42	46.17	18.41	4.80	------	11488	14517
3958	[26]B. M. 35	10/06	Madison-------	6	12.47	33.12	41.85	12.56	4.37	------	10667	------
					Dry	37.84	47.81	14.35	4.99	------	12186	14598
3980	[26]B. M. 35	10/06	Madison-------	6	12.25	33.76	41.66	12.33	4.42	------	10719	------
					Dry	38.47	47.48	14.05	5.04	------	12215	14578
2772	[26]B. M. 36	1/06	Madison-------	6	13.51	34.64	41.70	10.15	4.01	------	10881	------
					Dry	40.05	48.21	11.74	4.64	------	12580	14566
2773	[26]B. M. 36	1/06	Madison-------	6	13.83	34.16	42.24	9.77	4.10	------	-------	------
					Dry	39.64	49.02	11.34	4.76	------	-------	------
2905	[26]B. M. 36	1/06	Madison-------	6	11.91	35.65	39.43	13.01	5.34	------	10615	------
					Dry	40.47	44.76	14.77	6.06	------	12049	14551
2896	[26]B. M. 36	1/06	Madison-------	6	13.03	32.65	39.79	14.53	4.35	------	10192	------
					Dry	37.54	45.75	16.71	5.01	------	11718	14479
1341	[26]B. M. 38	9/04	Madison-------	6	15.09	31.00	46.49	7.42	.83	------	11151	------
					Dry	36.51	54.75	8.74	.98	------	13133	14533
1342	[27]B. M. 39	9/04	Madison-------	6	14.42	32.18	44.59	8.81	1.52	------	-------	------
					Dry	37.60	52.11	10.29	1.78	------	-------	------
1417	[27]B. M. 39	9/04	Madison-------	6	12.91	31.90	43.55	11.64	1.32	------	10804	------
					Dry	36.63	50.00	13.37	1.52	------	12406	14554

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[25] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 86, 1918.
[26] Ibid., p. 87.
[27] Ibid., p. 88.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
2270	[28]B. M. 39	9/04	Madison	6	15.23 Dry	31.42 37.06	44.32 52.29	9.03 10.65	1.59 1.88	------ ------	10901 12859	------ 14593
2271	[28]B. M. 39	9/04	Madison	6	17.79 Dry	28.78 35.01	42.34 51.50	11.09 13.49	1.40 1.70	------ ------	------ ------	------ ------
2852	[28]B. M. 39	9/04	Madison	6	15.54 Dry	31.26 37.01	42.27 50.05	10.93 12.94	1.38 1.63	------ ------	10507 12438	------ 14432
2920	[28]B. M. 39	9/04	Madison	6	15.30 Dry	30.59 36.12	43.40 51.24	10.71 12.64	1.43 1.69	------ ------	------ ------	------ ------
10956	[29]B. M. 40	9/10	Madison	6	12.94 Dry	35.76 41.07	41.92 48.16	9.38 10.77	3.65 4.19	------ ------	10973 12604	------ 14399
10957	[29]B. M. 40	9/10	Madison	6	12.31 Dry	37.57 42.84	41.09 46.86	9.03 10.30	3.58 4.08	------ ------	11115 12676	------ 14395
10958	[29]B. M. 40	9/10	Madison	6	12.81 Dry	36.31 41.64	41.35 47.43	9.53 10.93	3.28 3.76	------ ------	11023 12641	------ 14676
10959	[29]B. M. 40	9/10	Madison	6	12.70 Dry	36.36 41.65	41.47 47.50	9.47 10.85	3.67 4.20	------ ------	10989 12587	------ 14396
5039	87	6/12	Marion	6	10.06 Dry	37.96 42.21	41.09 45.69	10.89 12.10	3.92 4.35	.59 .66	11289 12555	------ 14589
5041	87	6/12	Marion	6	10.35 Dry	36.04 40.20	42.81 47.75	10.80 12.05	4.10 4.57	.25 .28	11227 12522	------ 14551
5044	87	6/12	Marion	6	10.96 Dry	36.54 41.04	40.68 45.69	11.82 13.27	4.00 4.52	.43 .48	11002 12364	------ 14583
80737	206	8/21	Marion	6	9.11 Dry	36.82 40.51	41.83 46.02	12.24 13.47	4.53 4.98	.32 .35	11119 12233	------ 14487
80738	206	8/21	Marion	6	9.05 Dry	37.00 40.68	41.78 45.94	12.17 13.38	4.93 5.42	.15 .16	11143 12252	------ 14838
80739	206	8/21	Marion	6	9.19 Dry	36.99 40.73	41.94 46.19	11.88 13.08	3.39 3.73	.74 .81	11243 12381	------ 14621
80740	206	8/21	Marion	6	11.32 Dry	35.62 40.17	42.16 47.54	10.90 12.29	3.98 4.49	.10 .11	11056 12467	------ 14528
80741	206	8/21	Marion	6	11.36 Dry	35.35 39.88	42.99 48.50	10.30 11.62	4.03 4.55	.15 .17	11137 12564	------ 14521
80742	206	8/21	Marion	6	9.59 Dry	36.93 40.85	42.67 47.19	10.81 11.96	3.51 3.88	.44 .49	11311 12511	------ 14499
80695	207	8/21	Marion	6	9.87 Dry	35.92 39.85	44.41 49.28	9.80 10.87	3.65 4.05	.16 .18	11494 12753	------ 14587
80696	207	8/21	Marion	6	10.63 Dry	37.26 41.69	42.04 47.04	10.07 11.27	2.87 3.21	.39 .44	11259 12598	------ 14451
80697	207	8/21	Marion	6	10.74 Dry	36.97 41.42	40.48 45.35	11.81 13.23	3.31 3.71	.76 .85	11048 12377	------ 14571
1725	[30]B. M. 52	6/05	Marion	6	10.25 Dry	37.43 41.70	39.79 44.34	12.53 13.96	3.70 4.12	------ ------	11077 12343	------ 14680

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[28] Ibid.
[29] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 85, p. 36, 1914.
[30] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 88, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
1726	[30]B. M. 52	6/05	Marion	6	11.88	35.84	43.45	8.83	3.25	------	------	------
					Dry	40.67	49.31	10.02	3.69	------	------	------
1761	[30]B. M. 52	6/05	Marion	6	9.95	34.76	42.06	13.23	3.87	------	10960	------
					Dry	38.60	46.71	14.69	4.30	------	12172	14620
5105	76	7/12	Montgomery	6	14.15	36.96	38.19	10.70	3.43	.91	10547	------
					Dry	43.05	44.48	12.47	4.00	1.06	12285	14329
5106	76	7/12	Montgomery	6	13.83	36.95	39.22	10.00	3.72	.91	10728	------
					Dry	42.88	45.51	11.61	4.32	1.05	12455	14382
5107	76	7/12	Montgomery	6	13.70	37.25	37.93	11.12	4.39	1.04	10444	------
					Dry	43.17	43.94	12.89	5.08	1.20	12102	14225
5516	77	8/12	Montgomery	6	14.00	36.88	40.02	9.10	3.84	.48	10761	------
					Dry	42.88	46.54	10.58	4.47	.57	12511	14268
81101	194	8/21	Montgomery	6	12.84	37.08	40.56	9.52	3.58	.71	10894	------
					Dry	42.54	46.54	10.92	4.11	.81	12499	14302
81102	194	8/21	Montgomery	6	13.28	36.02	40.55	10.15	4.15	.64	10671	------
					Dry	41.54	46.76	11.70	4.79	.74	12305	14239
81103	194	8/21	Montgomery	6	13.46	35.80	41.36	9.38	4.48	.13	10774	------
					Dry	41.37	47.79	10.84	5.18	.16	12450	14269
81093	195	8/21	Montgomery	6	12.65	36.14	41.55	9.66	3.87	.50	10793	------
					Dry	41.37	47.57	11.06	4.43	.57	12356	14171
81094	195	8/21	Montgomery	6	11.66	37.25	41.31	9.78	3.69	.69	11053	------
					Dry	42.17	46.76	11.07	4.18	.78	12512	14345
81095	195	8/21	Montgomery	6	14.32	34.82	41.97	8.89	3.94	.16	10687	------
					Dry	40.64	48.98	10.38	4.60	.19	12473	14530
81089	196	8/21	Montgomery	6	11.38	37.05	40.98	10.59	4.26	.96	10832	------
					Dry	41.81	46.24	11.95	4.81	1.08	12223	14189
81090	196	8/21	Montgomery	6	12.53	36.21	40.35	10.91	4.61	.85	10705	------
					Dry	41.40	46.13	12.47	5.27	.97	12258	14341
81091	196	8/21	Montgomery	6	12.47	37.13	40.54	9.86	4.41	.40	10861	------
					Dry	42.42	46.32	11.26	5.04	.46	12408	14284
81097	197	8/21	Montgomery	6	14.97	34.87	41.80	8.36	3.41	.44	10697	------
					Dry	41.01	49.16	9.83	4.01	.52	12580	14200
81098	197	8/21	Montgomery	6	14.49	34.60	42.45	8.46	3.83	.36	10643	------
					Dry	40.46	49.65	9.89	4.48	.42	12446	14070
81099	197	8/21	Montgomery	6	14.69	34.56	41.14	9.61	4.32	.47	10425	------
					Dry	40.51	48.23	11.26	5.06	.55	12220	14069
1661	[31]B. M. 43	5/05	Montgomery	6	12.90	33.77	42.25	11.08	3.78	------	10856	------
					Dry	38.77	48.51	12.72	4.34	------	12463	14599
1449	[31]B. M. 43	5/05	Montgomery	6	14.89	34.80	42.44	7.87	3.61	------	11016	------
					Dry	40.89	49.86	9.25	4.24	------	12944	14521
1450	[31]B. M. 43	5/05	Montgomery	6	13.94	33.93	41.22	10.91	3.79	------	------	------
					Dry	39.43	47.89	12.68	4.40	------	------	------
1557	[31]B. M. 43	5/05	Montgomery	6	14.43	29.48	42.81	13.28	4.01	------	10064	------
					Dry	34.45	50.03	15.52	4.69	------	11761	14289

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[31] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 89, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
1702	[31]B. M. 43	5/05	Montgomery---	6	11.93	29.99	43.90	14.18	4.29	------	10303	------
					Dry	34.05	49.85	16.10	4.87	------	11698	14329
1627	[31]B. M. 43	5/05	Montgomery---	6	13.20	34.33	39.94	12.53	4.47	------	10514	------
					Dry	39.55	46.01	14.44	5.15	------	12112	14529
11352	[32]B. M. 44	11/10	Montgomery---	6	13.23	34.45	42.37	9.95	3.57	------	-------	------
					Dry	39.70	48.83	11.47	4.11	------	-------	------
11353	[32]B. M. 44	11/10	Montgomery---	6	12.99	32.86	40.33	13.82	4.06	------	-------	------
					Dry	37.77	46.35	15.88	4.67	------	-------	------
11354	[32]B. M. 44	11/10	Montgomery---	6	13.31	33.62	41.34	11.73	3.75	------	10548	------
					Dry	38.78	47.69	13.53	4.33	------	12168	14394
21901	[33]B. M. 45	4/15	Montgomery---	6	14.87	33.42	40.70	11.01	3.26	------	10478	------
					Dry	39.26	47.81	12.93	3.83	------	12308	14419
21902	[33]B. M. 45	4/15	Montgomery---	6	12.70	35.52	40.16	11.62	4.15	------	10669	------
					Dry	40.69	46.00	13.31	4.75	------	12220	14432
21903	[33]B. M. 45	4/15	Montgomery---	6	13.04	34.06	39.58	13.32	4.84	------	10301	------
					Dry	39.17	45.51	15.32	5.57	------	11846	14388
21904	[33]B. M. 45	4/15	Montgomery---	6	13.43	35.06	40.96	10.55	3.82	------	10732	------
					Dry	40.50	47.31	12.19	4.41	------	12398	14425
21905	[33]B. M. 45	4/15	Montgomery---	6	13.31	34.86	40.42	11.41	4.02	------	10620	------
					Dry	40.21	46.63	13.16	4.64	------	12251	14438
21906	[33]B. M. 45	4/15	Montgomery---	6	13.48	34.84	40.13	11.55	4.03	------	10548	------
					Dry	40.27	46.38	13.35	4.66	------	12191	14402
5254	225	8/12	Moultrie-------	6	7.07	39.02	43.01	10.90	3.69	.36	11912	------
					Dry	41.99	46.28	11.73	3.97	.39	12819	14736
5255	225	8/12	Moultrie-------	6	7.18	38.09	41.38	13.35	5.18	.46	11573	------
					Dry	41.03	44.59	14.38	5.58	.49	12468	14973
5256	225	8/12	Moultrie-------	6	6.24	40.34	42.55	10.87	3.18	.89	12149	------
					Dry	43.03	45.38	11.59	3.39	.95	12957	14937
4756	54	3/12	Perry----------	6	10.32	34.03	46.19	9.46	1.07	.24	11395	------
					Dry	37.94	51.51	10.55	1.18	.26	12705	14380
4759	54	3/12	Perry----------	6	10.41	33.43	45.82	10.34	.88	.23	11486	------
					Dry	37.32	51.14	11.54	.98	.25	12822	14367
4760	54	3/12	Perry----------	6	10.22	33.32	47.60	8.86	1.04	.23	11270	------
					Dry	37.11	53.03	9.86	1.15	.25	12553	14383
4764	54	3/12	Perry----------	6	9.98	33.71	44.91	11.40	.84	.33	11205	------
					Dry	37.45	49.88	12.67	.93	.37	12447	14452
4766	54	3/12	Perry----------	6	9.64	33.49	45.60	11.27	.82	.35	11230	------
					Dry	37.06	50.47	12.47	.90	.39	12428	14394
4768	54	3/12	Perry----------	6	10.05	33.24	45.85	10.86	.93	.63	11257	------
					Dry	36.94	50.98	12.08	1.04	.70	12513	14424
5034	90	6/12	Perry----------	6	10.60	37.03	42.32	10.05	3.73	.62	11175	------
					Dry	41.42	47.35	11.23	4.17	.70	12500	14365
5037	90	6/12	Perry----------	6	11.20	37.29	40.57	10.94	3.20	.34	10911	------
					Dry	42.00	45.69	12.31	3.60	.39	12287	14288

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[32] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 85, p. 37, 1914.

[33] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines, Bull. 123, p. 35, 1918.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5038	90	6/12	Perry----------	6	10.60	35.99	43.05	10.36	4.18	.47	11012	------
					Dry	40.25	48.16	11.59	4.67	.53	12317	14228
5040	90	6/12	Perry----------	6	11.60	37.03	42.17	9.20	3.84	.38	11107	------
					Dry	41.89	47.71	10.40	4.34	.43	12570	14301
5042	90	6/12	Perry----------	6	10.82	37.83	41.52	9.83	2.98	.76	11210	------
					Dry	42.42	46.56	11.02	3.34	.85	12570	14380
5043	90	6/12	Perry----------	6	10.89	36.81	41.23	11.07	3.71	.55	10826	------
					Dry	41.29	46.27	12.44	4.16	.52	12277	14319
5048	88	7/12	Perry----------	6	9.37	36.87	41.05	12.71	4.62	.43	10936	------
					Dry	40.68	45.29	14.02	4.83	.47	12067	14395
5049	88	7/12	Perry----------	6	9.34	37.97	41.32	11.37	3.16	1.42	11099	------
					Dry	41.88	45.58	12.54	3.48	1.56	12243	14276
5050	88	7/12	Perry----------	6	10.11	36.44	41.45	12.00	3.59	.75	10915	------
					Dry	40.54	40.12	13.34	3.99	.81	12141	14321
5514	89	8/12	Perry----------	6	12.43	35.55	42.86	9.16	4.80	.21	11063	------
					Dry	40.59	48.94	10.47	5.48	.25	12632	14422
5519	89	8/12	Perry----------	6	12.76	35.18	44.32	7.74	1.66	.15	11357	------
					Dry	41.79	49.34	8.87	1.90	.17	13018	14458
5520	89	8/12	Perry----------	6	12.17	36.42	42.41	9.00	1.96	.46	11200	------
					Dry	41.46	48.28	10.26	2.23	.52	12753	14414
12596	175	5/21	Perry----------	6	10.11	35.92	43.55	10.42	3.62	.56	11661	------
					Dry	39.96	48.45	11.59	4.03	.62	12422	14332
12597	175	5/21	Perry----------	6	10.16	35.53	44.84	9.47	3.46	.11	11368	------
					Dry	39.55	49.91	10.54	3.85	.12	12654	14405
12598	175	5/21	Perry----------	6	10.16	35.49	42.89	11.46	3.92	.42	11041	------
					Dry	39.50	47.74	12.76	4.36	.47	12290	14402
12574	176	5/21	Perry----------	6	9.26	39.03	42.31	9.40	3.38	.30	11449	------
					Dry	43.01	46.63	10.36	3.73	.33	12617	14328
12575	176	5/21	Perry----------	6	9.52	36.11	43.88	10.49	3.47	.35	11330	------
					Dry	39.91	48.50	11.59	3.84	.39	12522	14218
12576	176	5/21	Perry----------	6	10.01	36.39	43.99	9.61	3.87	.84	11313	------
					Dry	40.44	48.88	10.68	3.19	.84	12572	14314
12577	176	5/21	Perry----------	6	10.61	36.25	43.49	9.65	3.40	.50	11125	------
					Dry	40.55	48.65	10.80	3.68	.56	12445	14205
12578	176	5/21	Perry----------	6	10.14	35.55	43.07	11.24	3.49	.40	10979	------
					Dry	39.56	47.93	12.51	3.89	.45	12218	14257
12579	176	5/21	Perry----------	6	11.52	34.89	43.18	10.41	2.99	.51	10887	------
					Dry	39.43	48.80	11.77	3.38	.58	12305	14205
12595	177	5/21	Perry----------	6	9.45	35.01	41.93	13.61	3.84	.86	10763	------
					Dry	38.66	46.31	15.03	4.24	.95	11886	14334
12620	178	5/21	Perry----------	6	9.29	35.59	42.81	12.31	3.31	.32	11019	------
					Dry	39.24	47.19	13.57	3.65	.34	12148	14358
12621	178	5/21	Perry----------	6	10.19	34.23	40.62	13.96	5.43	.37	10486	------
					Dry	38.12	46.34	15.54	6.05	.40	11676	14359
12622	178	5/21	Perry----------	6	9.84	35.15	43.16	11.85	3.54	.28	10942	------
					Dry	38.98	47.87	13.15	3.93	.30	12137	14275

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12664	179	6/21	Perry----------	6	8.79	36.91	43.31	10.99	3.43	.19	11300	------
					Dry	40.47	47.48	12.05	3.76	.21	12201	14368
12665	179	6/21	Perry----------	6	8.88	37.82	42.73	10.57	3.38	.06	11290	------
					Dry	41.51	46.89	11.60	3.71	.06	12204	14287
12623	180	6/21	Perry----------	6	8.29	34.61	48.18	8.92	1.07	.25	11703	------
					Dry	37.74	52.54	9.72	1.17	.27	12761	14292
12624	180	6/21	Perry----------	6	8.91	33.28	47.11	10.70	.95	.05	11355	------
					Dry	36.53	51.72	11.75	1.04	.06	12466	14311
12614	180	5/21	Perry----------	6	10.00	32.79	48.99	8.22	.77	.12	11570	------
					Dry	36.44	54.43	9.13	.86	.14	12855	14288
12615	180	5/21	Perry----------	6	9.89	33.47	47.05	9.59	1.35	.43	11424	------
					Dry	37.14	52.22	10.64	1.50	.48	12678	14372
12616	180	5/21	Perry----------	6	9.49	34.09	46.22	10.20	1.21	.18	11432	------
					Dry	37.67	51.06	11.27	1.33	.20	12632	14425
31033	181	10/18	Perry----------	6	12.34	33.48	45.02	9.16	1.82	------	11171	------
					Dry	38.19	51.36	10.45	2.08	------	12744	14434
31034	181	10.18	Perry----------	6	12.19	34.16	44.50	9.15	1.32	------	11245	------
					Dry	38.90	50.68	10.42	1.50	------	12805	14479
31035	181	10/18	Perry----------	6	11.93	33.50	45.35	9.22	1.36	------	11257	------
					Dry	38.04	51.49	10.47	1.54	------	12782	14447
31036	181	10/18	Perry----------	6	11.86	34.13	44.63	9.38	1.46	------	11236	------
					Dry	38.72	50.64	10.64	1.66	------	12748	14426
12592	182	5/21	Perry----------	6	9.06	36.59	43.13	11.22	3.73	.37	11126	------
					Dry	40.24	47.43	12.33	4.10	.41	12235	14246
12593	182	5/21	Perry----------	6	9.00	35.80	44.03	11.17	3.86	.46	11097	------
					Dry	39.34	48.39	12.27	4.24	.51	12195	14194
12594	182	5/21	Perry----------	6	9.21	35.02	44.58	11.19	3.55	.40	11194	------
					Dry	38.57	49.10	12.33	3.91	.44	12327	14350
12588	184	5/21	Perry----------	6	8.13	38.22	42.61	11.04	3.73	.58	11296	------
					Dry	41.60	46.38	12.02	4.06	.64	12296	14262
12589	184	5/21	Perry----------	6	7.56	37.65	43.56	11.23	3.71	.52	11336	------
					Dry	40.73	47.12	12.15	4.01	.57	12263	14245
12590	184	5/21	Perry----------	6	8.28	39.19	41.95	10.58	3.49	.43	11406	------
					Dry	42.73	45.74	11.53	3.81	.47	12436	14329
12591	184	5/21	Perry----------	6	8.00	37.60	42.27	12.13	3.38	.57	11124	------
					Dry	40.87	45.95	13.18	3.67	.62	12091	14218
20728	[34]B. M. 29	10/15	Perry----------	6	10.88	32.97	47.20	8.95	1.15	------	11380	------
					Dry	37.00	52.96	10.04	1.29	------	12769	14411
20729	[34]B. M. 29	10/15	Perry----------	6	10.20	33.08	49.63	7.09	.80	------	11749	------
					Dry	36.84	55.26	7.90	.89	------	13082	14329
20730	[34]B. M. 29	10/15	Perry----------	6	11.47	32.05	48.44	8.04	.92	------	11446	------
					Dry	36.20	54.72	9.08	1.04	------	12929	14368
20731	[34]B. M. 29	10/15	Perry----------	6	10.64	32.78	48.93	7.65	.68	------	11621	------
					Dry	36.68	54.76	8.56	.76	------	13005	14352

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[34] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 35, 1918.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
20732	[34]B. M. 29	10/15	Perry----------	6	11.54	32.16	49.35	6.95	.85	------	11578	------
					Dry	36.36	55.78	7.86	.96	------	13088	14332
20733	[34]B. M. 29	10/15	Perry----------	6	10.99	32.24	48.32	8.45	.72	------	11446	------
					Dry	36.22	54.29	9.49	.81	------	12859	14340
20734	[34]B. M. 29	10/15	Perry----------	6	11.03	32.40	48.64	7.93	.86	------	11578	------
					Dry	36.41	54.68	8.91	.97	------	13010	14426
26462	[35]	12/16	Perry----------	6	10.45	33.92	47.88	7.75	.83	------	11729	------
					Dry	37.88	53.97	8.65	.93	------	13097	14476
26463	[35]	12/16	Perry----------	6	10.66	33.04	47.60	8.70	.82	------	11590	------
					Dry	36.98	53.28	9.74	.92	------	12973	14529
26464	[35]	12/11	Perry----------	6	10.61	33.04	46.72	9.63	1.02	------	11412	------
					Dry	36.96	52.27	10.77	1.14	------	12767	14485
26465	[35]	12/16	Perry----------	6	11.26	33.84	46.18	8.72	.80	------	11484	------
					Dry	38.13	52.04	9.83	.90	------	12942	14509
26466	[35]	12/16	Perry----------	6	11.75	33.49	45.94	8.82	.78	------	11392	------
					Dry	37.95	52.06	9.99	.88	------	12908	14497
26467	[35]	12/16	Perry----------	6	11.47	32.81	47.22	8.50	1.08	------	11484	------
					Dry	37.06	53.34	9.60	1.22	------	12973	14514
26469	[35]	12/16	Perry----------	6	13.73	33.99	49.58	2.70	.77	------	12064	------
					Dry	39.40	57.47	3.13	.89	------	13984	14542
5045	83	8/12	Randolph------	6	11.38	36.94	40.25	11.43	4.16	.72	10823	------
					Dry	41.68	45.41	12.91	4.69	.81	12212	14348
5046	83	8/12	Randolph------	6	10.62	38.10	39.12	12.16	4.45	.42	10849	------
					Dry	42.63	43.77	13.60	4.98	.47	12137	14400
5047	83	8/12	Randolph------	6	11.39	36.80	41.04	10.77	4.11	.60	10895	------
					Dry	41.53	46.32	12.15	4.63	.67	12294	14306
12583	229	5/21	Randolph------	6	8.46	37.00	44.26	10.28	3.69	.29	11333	------
					Dry	40.42	48.35	11.23	4.03	.32	12381	14219
12584	229	5/21	Randolph------	6	8.71	37.46	42.94	10.89	4.45	.086	11155	------
					Dry	41.04	47.04	11.92	4.88	.094	12220	14181
12585	229	5/21	Randolph------	6	8.00	38.05	43.63	10.32	3.69	.162	11338	------
					Dry	41.36	47.42	11.22	4.01	.176	12324	14149
12562	208	5/21	Randolph------	6	9.54	36.55	43.35	10.56	3.21	.58	11251	------
					Dry	40.41	47.92	11.67	3.55	.64	12438	14349
12563	208	5/21	Randolph------	6	9.52	37.01	40.86	12.61	4.90	.46	10971	------
					Dry	40.90	45.16	13.94	5.42	.51	12125	14463
12564	208	5/21	Randolph------	6	9.69	37.31	41.70	11.30	4.15	.50	11135	------
					Dry	41.31	46.17	12.52	4.59	.55	12330	14412
12565	208	5/21	Randolph------	6	11.07	36.15	41.17	11.61	2.90	.69	10902	------
					Dry	40.65	46.30	13.05	3.47	.78	12259	14373
12566	208	5/21	Randolph------	6	10.58	35.65	39.85	13.92	3.20	.93	10526	------
					Dry	39.86	44.57	15.57	3.58	.98	11772	14273
12567	208	5/21	Randolph------	6	10.65	36.25	40.89	12.21	4.32	.52	10885	------
					Dry	40.57	45.76	13.67	4.84	.58	12182	14458

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[35] U. S. Bureau of Mines, unpublished analyses.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12580	209	5/21	Randolph------	6	10.35	37.35	41.41	10.69	3.73	.51	10991	------
					Dry	41.75	46.30	11.95	4.17	.57	12287	14244
12581	209	5/21	Randolph------	6	8.95	36.48	41.87	12.70	4.72	.66	10874	------
					Dry	40.06	45.99	13.95	5.19	.73	11943	14233
12582	209	5/21	Randolph------	6	9.44	36.89	42.42	11.25	4.31	.75	11016	------
					Dry	40.73	46.84	12.43	4.76	.83	12165	14205
12570	210	5/21	Randolph------	6	9.62	36.49	42.58	11.31	3.61	.21	11215	------
					Dry	40.37	47.11	12.52	3.99	.23	12409	14485
12571	210	5/21	Randolph------	6	9.03	37.38	43.63	9.96	3.42	.39	11456	------
					Dry	41.09	47.96	10.95	3.76	.43	12593	14408
12572	210	5/21	Randolph------	6	9.27	35.55	43.78	11.40	3.10	.29	11230	------
					Dry	39.18	48.25	12.57	3.42	.32	12378	14439
12573	210	5/21	Randolph------	6	9.42	35.40	41.85	13.33	3.91	.41	10858	------
					Dry	39.08	46.20	14.72	4.32	.45	11987	14404
5115	75	8/12	Sangamon-----	6	14.97	36.90	38.36	9.77	3.53	.59	10598	------
					Dry	43.39	45.12	11.49	4.16	.67	12466	14361
5116	75	8/12	Sangamon-----	6	14.51	37.60	39.69	8.20	3.44	.22	10911	------
					Dry	43.98	46.43	9.59	4.02	.25	12763	14373
5117	75	8/12	Sangamon-----	6	12.98	38.23	38.92	9.87	4.32	.56	10845	------
					Dry	43.94	44.72	11.34	4.96	.65	12463	14368
5130	74	7/12	Sangamon-----	6	15.22	38.23	37.36	9.19	4.38	.38	10579	------
					Dry	45.09	44.07	10.84	5.17	.45	12478	14301
5131	74	7/12	Sangamon-----	6	13.10	38.86	37.25	10.79	5.08	.41	10592	------
					Dry	44.72	42.86	12.42	5.86	.47	12187	14268
5132	74	7/12	Sangamon-----	6	14.43	38.14	37.07	10.36	4.77	.40	10495	------
					Dry	44.58	43.32	12.10	5.58	.47	12265	14292
81319	193	9/21	Sangamon-----	6	13.16	36.32	39.36	11.16	4.98	.51	10553	------
					Dry	41.82	45.33	12.85	5.73	.59	12152	14301
81320	193	9/21	Sangamon-----	6	13.25	36.73	40.75	9.27	3.53	.63	10884	------
					Dry	42.34	46.97	10.69	4.07	.73	12546	14314
81321	193	9/21	Sangamon-----	6	12.95	36.40	40.52	10.13	3.52	.56	10813	-----
					Dry	41.82	46.54	11.64	4.04	.64	12427	14346
2897	[36]B. M. 42	2/06	Sangamon-----	6	14.29	37.17	40.36	8.18	4.41	------	11007	------
					Dry	43.37	47.09	9.54	5.15	------	12841	14485
2898	[36]B. M. 42	2/06	Sangamon-----	6	14.18	34.85	41.11	9.86	4.36	------	-------	------
					Dry	40.61	47.90	11.49	5.08	------	-------	------
3052	[36]B. M. 42	2/06	Sangamon-----	6	16.00	32.41	37.82	13.77	4.05	------	9940	------
					Dry	38.58	45.03	16.39	4.82	------	11833	14553
5056	79	7/12	St. Clair-------	6	10.69	40.16	37.87	11.28	4.55	.58	11063	------
					Dry	44.97	42.39	12.64	5.10	.65	12387	14522
5058	79	7/12	St. Clair-------	6	12.12	38.61	40.61	8.66	3.10	.35	11217	------
					Dry	43.93	46.22	9.85	3.52	.39	12764	14399
5059	79	7/12	St. Clair-------	6	11.12	40.54	38.27	10.07	4.18	.32	11145	------
					Dry	45.61	43.06	11.33	4.70	.36	12540	14483

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[36] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 91, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5055	78	7/12	St. Clair	6	13.06	38.21	37.36	11.37	3.21	1.17	10741	------
					Dry	43.95	42.96	13.09	3.70	1.35	12354	14515
5060	78	7/12	St. Clair	6	11.44	38.73	38.11	11.72	4.26	.56	10841	------
					Dry	43.73	43.04	13.23	4.81	.64	12242	14447
5061	78	7/12	St. Clair	6	10.75	39.19	38.88	11.18	3.41	.67	11041	------
					Dry	43.91	43.56	12.53	3.82	.75	12371	14438
5077	81	7/12	St. Clair	6	11.35	39.68	38.59	10.38	4.05	.58	11036	------
					Dry	44.75	43.54	11.71	4.57	.65	12449	14404
5079	81	7/12	St. Clair	6	10.85	40.75	38.36	10.04	4.09	.58	11192	------
					Dry	45.71	43.03	11.26	4.58	.65	12554	14445
5080	81	7/12	St. Clair	6	11.50	40.68	37.91	9.91	3.96	.46	10908	------
					Dry	45.96	42.84	11.20	4.47	.52	12597	14482
5108	82	7/12	St. Clair	6	10.99	38.96	58.79	11.26	4.36	.36	11047	------
					Dry	43.77	43.59	12.64	4.90	.40	12411	14544
5109	82	7/12	St. Clair	6	13.42	39.23	36.92	10.43	4.92	.26	10753	------
					Dry	45.31	42.65	12.04	5.69	.31	12419	14474
5110	82	7/12	St. Clair	6	11.40	40.66	36.89	10.75	4.10	.57	11052	------
					Dry	46.23	41.63	12.14	4.63	.63	12472	14511
5524	80	7/12	St. Clair	6	10.11	39.72	38.87	11.30	3.69	.78	11051	------
					Dry	44.19	43.24	12.57	4.10	.86	12294	14361
5525	80	8/12	St. Clair	6	9.83	39.84	37.97	12.36	4.02	.87	10958	------
					Dry	44.19	42.11	13.70	4.45	.96	12152	14415
5526	80	8/12	St. Clair	6	10.19	38.44	40.41	10.96	3.95	.68	11127	------
					Dry	42.79	45.00	12.21	4.49	.78	12388	14418
80827	200	8/21	St. Clair	6	14.93	30.71	42.72	11.64	2.22	.24	10340	------
					Dry	36.10	50.22	13.68	2.61	.27	12155	14349
80828	200	8/21	St. Clair	6	12.71	31.53	45.31	10.45	1.65	.58	10809	------
					Dry	36.12	51.91	11.97	1.89	.66	12383	14282
80829	200	8/21	St. Clair	6	13.68	32.10	42.59	11.63	1.51	1.25	10573	------
					Dry	37.19	49.34	13.47	1.75	1.45	12249	14394
80823	201	8/21	St. Clair	6	11.64	37.40	41.80	9.16	3.66	.35	11177	------
					Dry	42.33	47.30	10.37	4.14	.40	12649	14376
80824	201	8/21	St. Clair	6	11.26	37.92	39.03	11.79	3.66	.67	10931	------
					Dry	42.73	43.98	13.29	4.12	.75	12318	14521
80825	201	8/21	St. Clair	6	12.08	37.02	41.58	9.32	3.77	.17	11153	------
					Dry	42.10	47.30	10.60	4.29	.19	12685	14715
12536	202	5/21	St. Clair	6	11.45	37.39	38.66	12.50	5.21	.32	10739	------
					Dry	42.22	43.66	14.12	5.88	.36	12128	14517
12537	202	5/21	St. Clair	6	10.65	35.54	40.93	12.88	4.21	.88	10782	------
					Dry	39.77	45.81	14.42	4.71	.99	12067	14459
12538	202	5/21	St. Clair	6	11.17	39.20	39.20	10.43	4.44	.31	11073	------
					Dry	44.13	44.13	11.74	5.00	.35	12465	14444
12541	203	5/21	St. Clair	6	9.72	39.13	40.02	11.13	4.87	.72	11228	------
					Dry	43.34	44.33	12.33	5.39	.80	12437	14534
12542	203	5/21	St. Clair	6	9.26	40.97	39.09	10.68	4.36	.53	11308	------
					Dry	45.15	43.08	11.77	4.80	.59	12462	14438

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12543	203	5/21	St. Clair	6	11.17 Dry	39.71 44.70	37.52 42.24	11.60 13.06	4.63 5.21	.69 .78	10826 12187	------ 14362
12544	203	5/21	St. Clair	6	10.59 Dry	39.83 44.54	39.99 44.73	9.59 10.73	4.09 4.57	.32 .36	11103 12419	------ 14192
12545	203	5/21	St. Clair	6	11.33 Dry	39.64 44.70	39.04 44.03	9.99 11.27	3.59 4.05	.18 .20	11153 12578	------ 14458
12546	203	5/21	St. Clair	6	10.00 Dry	40.32 44.80	40.28 44.76	9.40 10.44	4.43 4.92	.55 .61	11386 12651	------ 14422
12559	204	5/21	St. Clair	6	11.52 Dry	37.20 42.05	41.67 47.09	9.61 10.86	2.82 3.19	.10 .10	11155 12607	------ 14394
12556	205	5/21	St. Clair	6	10.39 Dry	36.91 41.19	41.73 46.57	10.97 12.24	2.89 3.23	.74 .83	11004 12280	------ 14255
12557	205	5/21	St. Clair	6	9.26 Dry	37.77 41.62	41.08 45.27	11.89 13.11	3.01 3.32	.37 .41	11170 12310	------ 14438
12558	205	5/21	St. Clair	6	9.36 Dry	37.18 41.02	40.86 45.08	12.60 13.90	4.02 4.44	.55 .61	10959 12091	------ 14378
4250	[37]B. M. 49	11/06	St. Clair	6	13.17 Dry	34.79 40.07	41.75 48.08	10.29 11.85	3.22 3.71	------ ------	------- -------	------ ------
4251	[38]B. M. 49	11/06	St. Clair	6	14.38 Dry	33.92 39.62	42.95 50.16	8.75 10.22	3.13 3.66	------ ------	10858 12681	------ 14373
4376	[38]B. M. 49	11/06	St. Clair	6	13.10 Dry	32.16 37.01	41.49 47.74	13.25 15.25	3.66 4.21	------ ------	10393 11959	------ 14465
1095	[39]B. M. 50	9/04	St. Clair	6	11.17 Dry	39.31 44.25	39.20 44.13	10.32 11.62	4.22 4.75	------ ------	11223 12634	------ 14610
1096	[39]B. M. 50	9/04	St. Clair	6	10.06 Dry	40.33 44.84	39.54 43.96	10.07 11.20	4.04 4.49	------ ------	------- -------	------ ------
1261	[39]B. M. 50	9/04	St. Clair	6	9.75 Dry	37.48 41.53	39.57 43.84	13.20 14.63	4.10 4.54	------ ------	11025 12217	------ 14672
1152	[39]B. M. 50	9/04	St. Clair	6	12.03 Dry	31.86 36.22	33.67 38.27	22.44 25.51	4.00 4.55	------ ------	9149 10400	------ 14541
3910	[39]B. M. 51	10/06	St. Clair	6	10.73 Dry	39.60 44.36	40.41 45.27	9.26 10.37	4.12 4.62	------ ------	------- -------	------ ------
3912	[39]B. M. 51	10/06	St. Clair	6	9.88 Dry	42.26 46.89	37.05 41.12	10.81 11.99	3.83 4.25	------ ------	11439 12694	------ 14733
4364	[39]B. M. 51	10/06	St. Clair	6	11.69 Dry	35.70 40.43	39.42 44.63	13.19 14.94	4.38 4.96	------ ------	10699 12116	------ 14624
4670	93	2/12	Vermilion	6	13.68 Dry	36.28 42.03	41.37 47.92	8.67 10.05	2.78 3.23	.45 .52	11101 12861	------ 14537
4671	93	2/12	Vermilion	6	15.50 Dry	33.32 39.43	43.11 51.03	8.07 9.54	1.86 2.20	.46 .62	10976 12989	------ 14558
4674	93	2/12	Vermilion	6	15.69 Dry	34.52 40.95	42.22 50.07	7.57 8.98	1.56 1.85	.53 .63	11019 13085	------ 14553

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[37] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 89, 1913.
[38] Ibid., p. 90.
[39] Ibid., p. 89.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
4676	93	2/12	Vermilion......	6	14.56	35.04	41.82	8.58	2.09	.74	11006	------
					Dry	41.01	48.95	10.04	2.45	.86	12881	14527
4678	93	2/12	Vermilion......	6	16.06	34.67	40.75	8.52	1.79	.90	10810	------
					Dry	41.32	48.53	10.15	2.14	1.07	12879	14537
4679	93	2/12	Vermilion......	6	15.95	34.66	42.06	7.33	1.41	.39	11041	------
					Dry	41.23	50.05	8.72	1.68	.46	13136	14557
4702	92	3/12	Vermilion......	6	15.53	33.60	39.46	11.41	2.32	.98	10404	------
					Dry	39.78	46.70	13.52	2.75	1.15	12317	14520
4703	92	3/12	Vermilion......	6	15.70	32.38	39.80	11.36	2.57	1.06	10392	------
					Dry	38.81	47.72	13.47	3.04	1.26	12328	14535
4704	92	3/12	Vermilion......	6	15.27	33.98	40.88	9.87	2.26	.69	10718	------
					Dry	40.10	48.24	11.66	2.66	.81	12649	14563
4706	95	3/12	Vermilion......	6	11.87	40.37	39.52	8.24	3.07	.74	11416	------
					Dry	45.80	44.86	9.34	3.48	.84	12953	14525
4707	95	3/12	Vermilion......	6	13.14	38.81	38.11	9.94	4.18	.88	10949	------
					Dry	44.69	43.87	11.44	4.82	1.02	12604	14549
4740	91	6/12	Vermilion......	6	13.58	35.20	39.83	11.39	3.19	.83	10821	------
					Dry	40.73	46.09	13.18	3.69	.96	12521	14733
4741	91	6/12	Vermilion......	6	13.63	34.56	41.19	10.62	2.91	.78	10954	------
					Dry	40.01	47.69	12.30	3.36	.90	12683	14747
4742	91	6/12	Vermilion......	6	14.50	35.98	40.49	9.03	2.43	.44	11090	------
					Dry	42.09	47.35	10.56	2.83	.52	12971	14740
4743	91	6/12	Vermilion......	6	14.20	35.79	42.05	7.96	1.83	.34	11295	------
					Dry	41.71	49.01	9.28	2.13	.39	13165	14703
4744	91	6/12	Vermilion......	6	13.99	35.26	42.68	8.07	1.67	.98	11271	------
					Dry	40.99	49.63	9.38	1.94	1.14	13104	14706
4745	91	6/12	Vermilion......	6	14.79	34.44	42.69	8.08	1.72	.98	11053	------
					Dry	40.42	50.10	9.48	2.02	1.15	12971	14519
4746	91	6/12	Vermilion......	6	15.14	33.70	40.19	10.97	2.50	.61	10663	------
					Dry	39.72	47.34	12.94	2.95	.72	12565	14712
84222	212	2/22	Vermilion......	6	13.6	34.0	42.6	9.8	2.4	.83	11020	------
					Dry	39.3	49.5	11.2	2.8	.96	12750	14601
84223	212	2/22	Vermilion......	6	13.8	35.2	41.3	9.7	2.7	.69	11010	------
					Dry	40.8	48.0	11.2	3.1	.80	12760	14620
84224	212	2/22	Vermilion......	6	15.3	32.8	44.1	7.8	1.8	.80	11100	------
					Dry	38.7	52.1	9.2	2.1	.94	13110	14627
14682	[40]B. M. 53	/10	Vermilion......	6	16.16	34.09	39.19	10.56	1.74	------	10433	------
					Dry	40.66	46.75	12.59	2.08	------	12443	14472
25413	[41]B. M. 54	6/16	Vermilion......	6	15.62	35.59	39.97	8.82	1.68	------	10845	------
					Dry	42.18	47.37	10.45	1.99	------	12852	14554
5030	86	6/12	Washington....	6	12.45	37.22	39.81	11.52	3.62	.67	10874	------
					Dry	42.03	44.96	13.01	4.09	.76	12281	14426
5033	86	6/12	Washington....	6	10.24	39.06	39.79	10.91	4.18	.30	11180	------
					Dry	43.51	44.33	12.16	4.65	.34	12456	14499

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[40] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 85, p. 37, 1914.

[41] Fieldner, A. C., and others, Analyses of coal: U. S. Bureau of Mines Bull. 123, p. 35, 1918.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO$_2$	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5035	86	6/12	Washington	6	10.69	38.76	39.01	11.54	3.98	.51	10963	------
					Dry	43.41	43.66	12.93	4.47	.57	12275	14418
80680	226	8/21	Washington	6	9.58	38.50	39.87	12.05	4.63	.49	10906	------
					Dry	42.58	44.09	13.33	5.12	.54	12061	14260
80681	226	8/21	Washington	6	9.41	39.02	40.33	11.24	3.59	.41	11172	------
					Dry	43.07	44.52	12.41	3.96	.45	12333	14374
80682	226	8/21	Washington	6	9.29	38.45	38.94	13.32	4.70	.66	10796	------
					Dry	42.39	42.93	14.68	5.18	.73	11902	14321
80594	228	7/21	White	6	8.20	34.68	48.79	8.33	2.93	.73	12079	------
					Dry	37.78	53.15	9.07	3.19	.80	13158	14700
80595	228	7/21	White	6	7.66	36.01	45.62	10.51	2.75	.96	11701	------
					Dry	39.08	49.51	11.41	2.98	1.04	12699	14586
80596	228	7/21	White	6	9.22	35.05	47.88	7.85	2.89	.23	11991	------
					Dry	38.61	52.74	8.65	3.18	.25	13209	14677
4998	65	6/12	Williamson	6	9.35	32.83	50.07	7.75	1.05	.26	12017	------
					Dry	36.21	55.24	8.55	1.16	.29	13256	14644
5004	65	6/12	Williamson	6	9.99	33.79	48.56	7.66	.99	.06	11899	------
					Dry	37.53	53.96	8.51	1.10	.06	13218	14593
5005	65	6/12	Williamson	6	8.58	33.95	48.31	9.16	3.10	.14	11845	------
					Dry	37.14	52.84	10.02	3.39	.16	12956	14644
4996	60	6/12	Williamson	6	8.32	34.61	47.56	9.51	2.25	.24	11978	------
					Dry	37.75	51.88	10.37	2.46	.26	13066	14801
5000	60	6/12	Williamson	6	7.53	34.90	47.37	10.20	3.23	.60	11799	------
					Dry	37.74	51.23	11.03	3.49	.65	12760	14607
5006	60	6/12	Williamson	6	8.81	32.13	51.85	7.21	1.00	.13	11962	------
					Dry	35.62	56.38	8.00	1.11	.16	13264	14572
5121	61	6/12	Williamson	6	9.44	33.63	49.58	7.35	1.28	.19	12092	------
					Dry	37.13	54.75	8.12	1.42	.21	13354	14685
5133	61	7/12	Williamson	6	8.99	34.22	49.51	7.28	1.70	.04	12149	------
					Dry	37.62	54.39	7.99	1.87	.04	13349	14674
5134	61	7/12	Williamson	6	9.38	33.62	50.01	6.99	1.12	.14	12138	------
					Dry	37.10	55.18	7.72	1.24	.16	13394	14654
5122	59	7/12	Williamson	6	9.79	33.28	48.66	8.27	1.32	.44	11891	------
					Dry	36.89	53.94	9.17	1.46	.49	13181	14681
5123	59	7/12	Williamson	6	10.67	32.54	47.32	9.47	1.53	.15	11619	------
					Dry	36.42	52.97	10.61	1.71	.17	13006	14748
5124	59	7/12	Williamson	6	10.96	33.14	45.86	10.04	1.72	.55	11383	------
					Dry	37.24	51.49	11.27	1.93	.62	12784	14624
5125	62	7/12	Williamson	6	9.97	32.20	49.62	8.21	1.47	.22	11814	------
					Dry	35.76	55.12	9.12	1.63	.25	13123	14610
5126	62	7/12	Williamson	6	8.37	34.19	50.18	7.26	1.03	.18	12254	------
					Dry	37.31	54.77	7.92	1.12	.20	13374	14663
5127	62	7/12	Williamson	6	9.06	32.93	49.98	8.03	1.03	.24	12010	------
					Dry	36.20	54.97	8.83	1.13	.27	13207	14637
5170	64	7/12	Williamson	6	11.51	30.75	49.74	8.00	.84	.32	11554	------
					Dry	34.76	56.20	9.04	.90	.36	13057	14501

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
5169	64	7/12	Williamson	6	9.13	32.03	51.06	7.77	1.10	.33	12044	------
					Dry	35.25	56.20	8.55	1.21	.36	13254	14613
5172	64	7/12	Williamson	6	7.38	35.59	47.56	9.47	.86	.51	12017	------
					Dry	38.42	51.35	10.23	.93	.55	12974	14617
5180	63	7/12	Williamson	6	10.38	32.76	48.10	8.76	1.50	.16	11735	------
					Dry	36.56	53.67	9.77	1.67	.18	13072	14672
5181	63	7/12	Williamson	6	8.78	34.25	47.56	9.41	2.49	.53	11885	------
					Dry	37.54	52.14	10.32	2.73	.58	13029	14758
5182	63	7/12	Williamson	6	9.26	33.36	48.70	8.68	1.83	.39	11955	------
					Dry	36.76	53.68	9.56	2.01	.43	13176	14761
80603	148	7/21	Williamson	6	8.00	33.66	50.86	7.48	1.08	.13	12266	------
					Dry	36.59	55.28	8.13	1.17	.14	13333	14655
80602	148	7/21	Williamson	6	8.14	32.87	49.99	9.00	1.43	.14	12015	------
					Dry	35.78	54.42	9.80	1.56	.16	13080	14681
80604	148	7/21	Williamson	6	7.85	33.92	49.60	8.63	1.14	.18	12107	------
					Dry	36.81	53.83	9.36	1.24	.20	13138	14656
80611	149	7/21	Williamson	6	5.62	36.04	44.78	13.56	4.21	.69	11621	------
					Dry	38.19	47.44	14.37	4.46	.81	12313	14738
80610	149	7/21	Williamson	6	5.65	36.49	47.69	10.17	3.54	.55	12100	------
					Dry	38.68	50.54	10.78	3.75	.62	12825	14644
80612	149	7/21	Williamson	6	7.66	32.76	51.12	8.46	1.51	.05	12074	------
					Dry	35.48	55.36	9.16	1.64	.06	13076	14621
12793	150	6/21	Williamson	6	6.14	34.47	48.04	11.35	3.57	.25	11722	------
					Dry	36.73	51.18	12.09	3.80	.27	12489	14494
12794	150	6/21	Williamson	6	5.96	35.07	47.56	11.41	4.37	.07	11791	------
					Dry	37.29	50.57	12.14	4.65	.07	12538	14591
12795	150	6/21	Williamson	6	5.85	35.46	47.48	11.11	4.06	.46	11845	------
					Dry	37.66	50.43	11.81	4.31	.48	12581	14568
80615	151	7/21	Williamson	6	7.15	37.17	46.55	9.13	3.03	.11	12028	------
					Dry	40.03	50.14	9.83	3.26	.12	12954	14603
80614	151	7/21	Williamson	6	6.33	36.22	46.84	10.61	3.29	.04	11900	------
					Dry	38.67	50.00	11.33	3.51	.05	12704	14597
80616	151	7/21	Williamson	6	7.25	35.84	47.88	9.03	2.04	.16	12118	------
					Dry	38.64	51.62	9.74	2.20	.17	13065	14675
12769	152	6/21	Williamson	6	6.76	31.08	52.76	9.40	1.16	.13	12128	------
					Dry	33.33	56.59	10.08	1.24	.14	13007	14639
12770	152	6/21	Williamson	6	7.19	32.65	50.12	10.04	1.36	.75	11928	------
					Dry	35.18	54.00	10.82	1.47	.81	12778	14603
12771	152	6/21	Williamson	6	7.14	33.07	52.02	7.77	1.44	.05	12297	------
					Dry	35.61	56.02	8.37	1.55	.05	13242	14610
30872	153	10/18	Williamson	6	9.13	32.21	47.97	10.69	.80	------	11500	------
					Dry	35.45	52.79	11.76	.88	------	12656	14543
30873	153	10/18	Williamson	6	8.84	32.52	49.81	8.83	1.09	------	11873	------
					Dry	35.67	54.64	9.69	1.20	------	13023	14584
30874	153	9/18	Williamson	6	9.75	33.36	51.37	5.52	.88	------	12280	------
					Dry	36.96	56.92	6.12	.98	------	13606	14601

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
30875	153	10/18	Williamson-----	6	10.82	31.11	49.02	9.05	.88	------	11646	------
					Dry	34.88	54.97	10.15	.99	------	13059	14700
12799	154	6/21	Williamson-----	6	7.75	31.88	51.20	9.17	1.45	.18	11987	------
					Dry	34.56	55.50	9.94	1.57	.20	12994	14611
12800	154	6/21	Williamson-----	6	8.53	32.12	52.30	7.05	1.13	.17	12253	------
					Dry	35.11	57.18	7.71	1.23	.19	13396	14654
12801	154	6/21	Williamson-----	6	7.42	32.85	50.39	9.34	1.01	.18	12084	------
					Dry	35.48	54.43	10.09	1.09	.20	12997	14687
12752	155	6/21	Williamson-----	6	7.83	32.54	51.91	7.72	1.35	.14	12092	------
					Dry	35.30	56.32	8.38	1.47	.16	13045	14471
12753	155	6/21	Williamson-----	6	7.51	34.23	50.61	7.65	1.28	.15	12179	------
					Dry	37.01	54.72	8.27	1.38	.17	13099	14504
12754	155	6/21	Williamson-----	6	9.29	31.49	50.75	8.47	.93	.15	11781	------
					Dry	34.72	55.94	9.34	1.03	.16	12987	14480
12822	156	6/21	Williamson-----	6	8.38	31.25	53.08	7.29	1.12	.05	12067	------
					Dry	39.11	57.93	7.96	1.22	.05	13171	14449
12823	156	6/21	Williamson-----	6	9.18	31.10	52.33	7.39	1.32	.16	11956	------
					Dry	34.25	57.61	8.14	1.45	.18	13164	14468
12824	156	6/21	Williamson-----	6	8.71	31.98	52.07	7.24	.94	.12	12062	------
					Dry	35.03	57.04	7.93	1.03	.14	13213	14483
12841	156	6/21	Williamson-----	6	7.42	37.81	53.51	7.26	1.22	.07	12250	------
					Dry	34.36	57.80	7.84	1.32	.07	13166	14500
12842	156	6/21	Williamson-----	6	7.53	32.41	53.95	6.11	2.41	.22	12416	------
					Dry	35.05	58.34	6.61	2.61	.24	13297	14543
80598	157	7/21	Williamson-----	6	7.19	35.82	47.55	9.44	2.90	.26	12074	------
					Dry	38.59	51.24	10.17	3.12	.28	13009	14722
80599	157	7/21	Williamson-----	6	8.17	35.03	46.87	9.93	3.08	.29	11893	------
					Dry	38.15	51.04	10.81	3.35	.30	12951	14782
80600	157	7/21	Williamson-----	6	9.25	32.70	50.57	7.48	1.52	.17	12056	------
					Dry	36.03	55.73	8.24	1.67	.19	13285	14650
12819	158	6/21	Williamson-----	6	7.47	32.15	51.38	9.00	2.37	.32	11885	------
					Dry	34.75	55.52	9.73	2.56	.35	12845	14551
12820	158	6/21	Williamson-----	6	8.24	30.97	51.39	9.40	2.75	.00	11776	------
					Dry	33.75	56.10	10.25	3.00	.00	12683	14531
12821	158	6/21	Williamson-----	6	9.91	30.11	52.87	7.11	1.55	.02	11923	------
					Dry	33.42	58.69	7.89	1.72	.02	13148	14523
12796	159	6/21	Williamson-----	6	7.79	32.17	52.09	7.95	1.72	.06	12157	------
					Dry	34.89	56.49	8.62	1.87	.06	13184	14599
12797	159	6/21	Williamson-----	6	6.89	37.72	48.39	11.00	3.99	.25	11768	------
					Dry	36.22	51.96	11.81	4.29	.27	12424	14635
12798	159	6/21	Williamson-----	6	8.10	30.89	50.72	10.29	3.62	.09	11717	------
					Dry	33.61	55.19	11.20	3.94	.09	12553	14642
12868	160	7/21	Williamson-----	6	8.81	31.54	50.60	9.05	1.46	.06	11783	------
					Dry	34.59	55.49	9.92	1.60	.06	12841	14524
12869	160	7/21	Williamson-----	6	8.52	31.66	52.11	7.71	1.17	.09	12094	------
					Dry	34.61	56.96	8.43	1.29	.09	13155	14586

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO_2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12870	160	7/21	Williamson.....	6	6.88 Dry	34.57 37.12	49.39 53.04	9.16 9.84	3.79 4.07	.02 .02	12022 12706	------ 14582
28810	161	7/17	Williamson.....	6	8.31 Dry	32.40 35.34	50.75 55.35	8.54 9.31	1.33 1.45	------ ------	11965 13048	------ 14553
28811	161	8/17	Williamson.....	6	9.13 Dry	31.48 34.64	51.00 56.13	8.39 9.23	.97 1.07	------ ------	11822 13010	------ 14485
28812	161	7/17	Williamson.....	6	8.82 Dry	35.15 38.55	47.90 52.53	8.13 8.92	1.07 1.17	------ ------	11965 13122	------ 14557
28813	161	7/17	Williamson.....	6	9.31 Dry	32.93 36.31	49.63 54.73	8.13 8.96	.82 .90	------ ------	11902 13124	------ 14559
28814	161	7/17	Williamson.....	6	9.78 Dry	33.08 36.67	49.93 55.34	7.21 7.99	.75 .83	------ ------	11965 13262	------ 14541
30863	162	9/18	Williamson.....	6	9.72 Dry	32.84 36.38	50.65 56.10	6.79 7.52	.96 1.06	------ ------	12026 13322	------ 14533
30864	162	9/18	Williamson.....	6	9.40 Dry	34.38 37.95	47.35 52.26	8.87 9.79	1.28 1.41	------ ------	11801 13027	------ 14614
30865	162	9/18	Williamson.....	6	10.58 Dry	32.47 36.31	46.30 51.78	10.65 11.91	1.57 1.76	------ ------	11322 12661	------ 14590
13540	163	3/22	Williamson.....	6	6.63 Dry	36.47 39.06	47.40 50.77	9.49 10.17	3.06 3.30	------ ------	12133 12995	------ 14713
13543	163	3/22	Williamson.....	6	7.59 Dry	33.61 36.37	49.25 53.29	9.55 10.34	2.72 2.94	------ ------	11974 12958	------ 14687
13544	163	3/22	Williamson.....	6	6.01 Dry	35.21 37.46	47.68 50.73	11.10 11.81	3.54 3.77	------ ------	11867 12526	------ 14484
13542	163	3/22	Williamson.....	6	7.11 Dry	34.56 37.20	46.85 50.44	11.48 12.35	2.89 3.11	------ ------	11668 12561	------ 14603
13539	163	3/22	Williamson.....	6	6.49 Dry	35.49 37.95	46.95 50.21	11.07 11.84	3.49 3.73	------ ------	11821 12641	------ 14621
13541	163	3/22	Williamson.....	6	5.93 Dry	34.60 36.78	47.58 50.58	11.89 12.64	3.27 3.48	------ ------	11788 12532	------ 14637
13538	164	3/22	Williamson.....	6	7.31 Dry	34.18 36.88	46.48 50.15	12.02 12.97	3.07 3.31	------ ------	11635 12553	------ 14726
80653	165	8/21	Williamson.....	6	6.51 Dry	34.93 37.36	46.12 49.33	12.44 13.31	4.21 4.50	1.01 1.08	11697 12511	------ 14773
80652	165	8/21	Williamson.....	6	8.79 Dry	32.97 36.15	48.73 53.42	9.51 10.43	1.61 1.77	.60 .66	11819 12958	------ 14663
80651	165	8/21	Williamson.....	6	8.82 Dry	31.24 34.26	52.45 57.53	7.49 8.21	.92 1.01	.49 .54	12047 13212	------ 14530
12838	166	6/21	Williamson.....	6	7.85 Dry	32.46 35.23	49.17 53.36	10.52 11.41	3.03 3.28	.82 .88	11675 12508	------ 14564
12839	166	6/21	Williamson.....	6	8.08 Dry	32.30 35.14	50.78 55.24	8.84 9.62	2.00 2.18	.21 .23	11867 12801	------ 14479
12840	166	6/21	Williamson.....	6	6.47 Dry	33.63 35.96	48.02 51.34	11.88 12.70	3.57 3.71	.64 .69	11659 12279	------ 14578
12875	167	7/21	Williamson.....	6	8.10 Dry	31.22 33.97	53.02 57.69	7.66 8.34	1.15 1.25	.13 .14	12156 13164	------ 14595

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
12876	167	7/21	Williamson	6	8.79 Dry	32.42 35.54	48.41 53.08	10.38 11.38	1.59 1.74	.48 .53	11573 12688	---- 14524
12877	167	7/21	Williamson	6	6.47 Dry	34.62 37.01	49.61 53.05	9.30 9.94	2.92 3.12	.20 .22	12046 12723	---- 14533
12881	168	7/21	Williamson	6	5.00 Dry	37.42 39.39	46.61 49.06	10.97 11.55	3.13 3.29	.28 .30	12108 12580	------ 14676
12882	168	7/21	Williamson	6	4.94 Dry	36.99 38.91	46.71 49.14	11.36 11.95	3.39 3.57	.44 .46	12106 12557	----- 14750
12883	168	7/21	Williamson	6	5.73 Dry	35.37 37.52	44.97 47.71	13.93 14.77	4.17 4.42	.36 .38	11514 12215	------ 14695
12772	169	6/21	Williamson	6	5.48 Dry	36.28 38.38	47.15 49.89	11.09 11.73	3.78 4.00	.61 .65	11879 12568	-- 14545
12773	169	6/21	Williamson	6	5.88 Dry	35.63 37.86	46.19 49.07	12.30 13.07	3.77 4.01	.45 .47	11631 12158	------ 14529
12774	169	6/21	Williamson	6	6.95 Dry	34.41 36.98	48.47 52.09	10.17 10.93	4.02 4.32	.03 .03	11848 12517	--- 14585
80625	170	7/21	Williamson	6	6.40 Dry	36.71 39.22	47.70 50.96	9.19 9.82	3.41 3.64	.04 .04	12150 12981	------ 14644
80626	171	7/21	Williamson	6	7.29 Dry	34.93 37.68	47.65 51.39	10.13 10.93	3.78 4.08	.04 .04	11745 12669	------ 14334
80670	172	8/21	Williamson	6	6.40 Dry	36.38 38.87	48.20 51.49	9.02 9.64	3.45 3.69	.04 .04	12179 13012	---- 14648
80673	173	8/21	Williamson	6	7.14 Dry	35.39 38.11	44.61 48.04	12.86 13.85	4.35 4.68	.63 .68	11481 12364	---- 14708
80671	173	8/21	Williamson	6	6.24 Dry	36.41 38.83	44.45 47.41	12.90 13.76	3.56 3.80	.90 .96	11672 12449	------ 14761
80672	173	8/21	Williamson	6	7.49 Dry	36.37 39.31	46.95 50.76	9.19 9.93	2.73 2.95	.04 .04	12080 13058	---- 14894
10632	[42]174	------	Williamson	6	6.40 Dry	33.26 35.53	50.68 54.15	9.66 10.32	2.29 2.45	------ ------	12109 12936	-- 14642
10658	[42]174	2/19	Williamson	6	7.47 Dry	33.79 36.52	49.41 53.39	9.33 10.09	1.77 1.92	------ ------	11970 12933	---- 14578
13537	227	3/22	Williamson	6	9.09 Dry	31.39 34.15	52.10 56.69	8.42 9.16	1.09 1.20	------ ------	11999 13199	---- 14688
1683	[43]B. M. 23	6/05	Williamson	6	8.29 Dry	31.19 34.01	49.69 54.18	10.83 11.81	2.81 3.06	------ ------	11837 12906	----- 14903
1688	[43]B. M. 23	6/05	Williamson	6	8.41 Dry	34.27 37.42	45.44 49.61	11.88 12.97	3.63 3.96	------ ------	------ ------	------ ------
1762	[43]B. M. 23	6/05	Williamson	6	8.20 Dry	32.26 35.14	46.59 50.75	12.95 14.11	3.48 3.79	------ ------	11362 12377	------ 14564

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[42] Analyses of a sample of forked coal.
[43] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 91, 1913.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
3907	[43]B. M. 23	6/05	Williamson.....	6	12.61 Dry	30.08 34.42	46.81 53.56	10.50 12.02	2.37 2.71	....	11066 12663	 14645
4083	[43]B. M. 23	6/05	Williamson.....	6	15.31 Dry	28.93 34.16	45.29 53.48	10.47 12.36	2.31 2.74	....	10820 12776	 14843
4201	[43]B. M. 23	6/05	Williamson.....	6	15.87 Dry	28.19 33.51	46.42 55.17	9.52 11.32	2.34 2.78	....	10784 12818	 14699
1634	[43]B. M. 24	5/05	Williamson.....	6	8.30 Dry	33.75 36.80	48.69 53.10	9.26 10.10	2.82 3.08	....	11999 13084	 14795
1654	[43]B. M. 24	5/05	Williamson.....	6	7.76 Dry	31.44 34.08	50.19 54.42	10.61 11.50	1.97 2.14	....	11957 12964	 14879
1660	[44]B. M. 24	5/05	Williamson.....	6	8.86 Dry	31.25 34.29	48.23 52.92	11.66 12.79	2.46 2.70	....	11702 12839	 14996
1718	[44]B. M. 24	5/05	Williamson.....	6	8.61 Dry	32.40 35.45	51.33 56.17	7.66 8.38	1.65 1.81	....	12236 13388	 14782
1653	[45]B. M. 24	5/05	Williamson.....	6	7.64 Dry	32.12 34.78	49.80 53.92	10.44 11.30	2.01 2.18	....	11939 12928	 14802
1802	[45]B. M. 24	5/05	Williamson.....	6	10.14 Dry	30.99 34.49	51.43 57.23	7.44 8.28	1.52 1.69	....	12116 13482	 14863
5238	[45]B. M. 24	6/07	Williamson.....	6	9.18 Dry	27.30 30.06	55.40 61.00	8.12 8.94	.90 .99	....	12015 13230	 14675
5215	[45]B. M. 24	6/07	Williamson.....	6	7.88 Dry	31.20 33.87	49.89 54.16	11.03 11.97	2.99 3.25	....	11741 12746	 14754
1731	[45]B. M. 25	6/05	Williamson.....	6	9.37 Dry	30.69 33.86	52.57 58.01	7.37 8.13	1.25 1.38	....	12058 13306	 14633
1732	[45]B. M. 25	6/05	Williamson.....	6	8.59 Dry	31.07 33.99	53.37 58.38	6.97 7.63	1.78 1.95	....	....	....
1820	[45]B. M. 25	6/05	Williamson.....	6	8.43 Dry	30.08 32.85	51.89 56.67	9.60 10.48	1.14 1.24	....	11959 13061	 14771
3629	[45]B. M. 25	6/05	Williamson.....	6	8.72 Dry	30.38 33.28	53.28 58.37	7.62 8.35	1.00 1.10	....	12200 13365	 14726
3632	[46]B. M. 25	6/05	Williamson.....	6	8.88 Dry	29.49 32.37	53.60 58.82	8.03 8.81	.99 1.09	....	....	....
3636	[46]B. M. 25	6/05	Williamson.....	6	8.80 Dry	29.85 32.73	53.83 59.02	7.52 8.25	1.13 1.24	....	12222 13401	 14754
3789	[46]B. M. 25	6/05	Williamson.....	6	7.78 Dry	29.85 32.37	52.39 56.81	9.98 10.82	1.32 1.43	....	11959 12969	 14734
1170	[46]B. M. 26	6/05	Williamson.....	6	7.50 Dry	31.68 34.25	53.67 58.02	7.15 7.73	.99 1.07	....	12386 13388	 14642

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[44] Ibid., p. 92.

[45] Lord, N. W., and others, Analyses of coals: U. S. Bureau of Mines Bull. 22, pt. 1, p. 92, 1913.

[46] Ibid, p. 93.

TABLE 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Continued.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO₂	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
1171	[46]B. M. 26	6/05	Williamson	6	7.34 Dry	34.29 37.01	50.84 54.86	7.53 8.13	2.04 2.20	------ ------	------ ------	------ ------
1318	[46]B. M. 26	6/05	Williamson	6	8.50 Dry	29.47 32.21	50.75 55.46	11.28 12.33	1.72 1.88	------ ------	11776 12870	------ 14916
19714	[47]	7/14	Williamson	7	7.28 Dry	32.03 34.54	50.00 53.93	10.69 11.53	1.91 2.06	------ ------	11804 12731	------ 14612
17719	[48]B. M. 27	8/13	Williamson	6	8.77 Dry	32.64 35 78	51.41 56.35	7.18 7.87	1.10 1.21	------ ------	12177 13347	------ 14626
17721	[48]B. M. 27	8/13	Williamson	6	8.70 Dry	31.78 34.81	51.89 56.83	7.63 8.36	1.00 1.10	------ ------	12173 13334	------ 14694
17720	[48]B. M. 27	8/13	Williamson	6	9.37 Dry	32.83 36.22	49.63 54.77	8.17 9.01	1.70 1.88	------ ------	11988 13228	------ 14717
28810	[49]B. M. 28	8/17	Williamson	6	8.31 Dry	32.40 35.34	50.75 50.35	8.54 9.31	1.33 1.45	------ ------	11965 13048	------ 14553
28811	[49]B. M. 28	8/17	Williamson	6	9.13 Dry	31.48 34.64	51.00 56.13	8.39 9.23	.97 1.07	------ ------	11822 13010	------ 14485
28812	[49]B. M. 28	8/17	Williamson	6	8.82 Dry	35.15 38.55	47.90 52.53	8.13 8.92	1.07 1.17	------ ------	11965 13122	------ 14559
28813	[49]B. M. 28	8/17	Williamson	6	9.31 Dry	32.93 36.31	49.63 54.73	8.13 8.96	.82 .90	------ ------	11902 13124	------ 14559
28814	[49]B. M. 28	8/17	Williamson	6	9.78 Dry	33.08 36.67	49.93 55.34	7.21 7.99	.75 .83	------ ------	11965 13262	------ 14381
No. 7 Coal.												
5416	99	8/12	LaSalle	7	13.82 Dry	41.42 48.06	35.90 41.67	8.86 10.27	3.95 4.58	.51 .59	11174 12966	------ 14744
5414	99	8/12	LaSalle	7	12.87 Dry	42.40 48.67	37.35 42.86	7.88 8.47	3.86 4.44	.00 .00	11468 13161	------ 14635
5417	99	8/12	LaSalle	7	13.99 Dry	38.81 45.12	40.12 46.65	7.08 8.23	3.23 3.76	.00 .00	11401 13255	------ 14675
4711	94	3/12	Vermilion	7	12.20 Dry	39.53 45.03	38.38 43.70	9.89 11.27	3.76 4.29	.46 .52	11243 12804	------ 14730
4713	94	3/12	Vermilion	7	12.70 Dry	39.20 44.90	39.24 44.95	8.86 10.15	2.79 3.19	.52 .59	11399 13057	------ 14776
4714	94	3/12	Vermilion	7	12.76 Dry	38.84 44.53	38.31 43.91	10.09 11.56	3.91 4.48	.61 .70	11106 12788	------ 14773
4716	94	3/12	Vermilion	7	12.67 Dry	39.01 44.67	37.43 42.86	10.89 12.47	3.54 4.06	.84 .96	11041 12644	------ 14734
4722	94	3/12	Vermilion	7	13.53 Dry	37.39 43.24	39.57 45.76	9.51 11.00	3.20 3.70	.46 .54	11045 12773	------ 14622
4724	94	3/12	Vermilion	7	13.27 Dry	37.25 42.95	40.65 46.87	8.83 10.18	3.27 3.77	.38 .44	11209 12925	------ 14650

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[47] Fieldner, A. C., and others, Analyses of coals: U. S. Bureau of Mines Bull. 123, p. 36, 1918. Run of mine sample. Not included in averages.

[48] Ibid, p. 36.

[49] U. S. Bureau of Mines, unpublished analyses.

Table 2.—*Analyses of mine samples (not exactly indicative of commercial output)*—Concluded.

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal 1st: "As received," with total moisture 2nd: "Dry" or moisture free				Sulphur	CO^2	B. t. u.	Unit coal
					Moisture	Volatile matter	Fixed carbon	Ash				
4727	97	3/12	Vermilion	7	12.92	36.98	38.94	11.16	2.90	.70	10924	------
					Dry	42.46	44.73	12.81	3.33	.80	12544	14715
4734	97	3/12	Vermilion	7	13.10	38.42	39.14	9.34	2.26	.56	11281	------
					Dry	44.22	45.03	10.75	2.59	.64	12981	14778
4736	97	3/12	Vermilion	7	13.41	37.33	38.87	10.39	2.54	.46	11065	------
					Dry	43.11	44.89	12.00	2.93	.53	12778	14787
84226	211	2/22	Vermilion	7	13.1	37.7	39.8	9.4	2.8	.59	11110	------
					Dry	43.4	45.8	10.8	3.2	.69	12770	14564
84227	211	2/22	Vermilion	7	14.1	37.0	39.3	9.6	2.9	.86	11030	------
					Dry	43.1	45.7	11.2	3.4	1.0	12840	14727
84228	211	2/22	Vermilion	7	13.7	37.0	39.5	9.8	3.2	.70	11050	------
					Dry	42.9	45.7	11.4	3.7	.81	12800	14724

Table 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts.*

DISTRICT NO. 1—BUREAU CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
1	16.19	37.79	38.06	8.00	3.24	.82	10787	------------
	Dry	45.06	45.40	9.54	3.86	.98	12869	14476
8	16.50	38.48	37.59	7.43	2.40	1.16	10868	------------
	Dry	46.08	45.02	8.90	2.90	1.39	13016	14493
10	16.13	38.82	38.36	6.69	3.15	.70	10994	------------
	Dry	46.28	45.74	7.98	3.76	.84	13108	14463
Average	16.27	38.35	38.00	7.38	2.93	.89	10883	------------
	Dry	45.80	45.39	8.81	3.50	1.40	12997	14477

DISTRICT NO. 1—GRUNDY CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
5	16.01	39.32	38.51	6.16	2.75	1.32	11104	------------
	Dry	46.83	45.84	7.33	3.28	1.57	13221	14463
6	19.53	37.59	37.94	4.94	2.01	.70	10818	------------
	Dry	46.71	47.15	6.14	2.61	.87	13444	14447
7	16.29	38.46	40.53	4.72	2.17	.48	11394	------------
	Dry	45.94	48.42	5.64	2.59	.57	13613	14579
Average	17.28	38.48	39.02	5.27	2.33	.83	11113	------------
	Dry	46.49	47.14	6.37	2.82	1.00	13426	14496

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts.*—Continued.

DISTRICT NO. 1—LA SALLE CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO2	B. t. u.	"Unit coal"
2	14.60	39.88	36.97	8.55	3.97	.81	10904	------------
	Dry	46.70	43.29	10.01	4.65	.95	12768	14475
3	15,05	39.76	37.00	8.19	3.30	.59	10899	------------
	Dry	46.80	43.56	9.64	3.88	.69	12830	14448
9	17.45	38.98	34.52	9.04	3.18	1.49	10391	------------
	Dry	47.22	41.82	10.95	3.85	1.81	12587	14402
102	14.7	34.9	42.3	8.06	3.26	.73	11056	------------
	Dry	40.9	49.6	9.46	3.86	.84	12960	14892
103	12.4	39.40	41.27	6.65	2.61	----------	11779	------------
	Dry	44.99	47.10	7.90	2.97	----------	13448	14805
B. M.	13.93	36.78	40.34	8.93	3.45	----------	11192	------------
1	Dry	46.87	46.87	10.37	4.00	----------	12883	14767
Average	14.58	38.28	42.01	8.23	3.29	.90	11020	------------
	Dry	45.58	45.37	9.72	3.86	1.06	12912	14632

DISTRICT NO. 1—MARSHALL CO., NO. 2 COAL

4	16.93	37.57	39.57	5.93	2.53	.37	11188	------------
	Dry	45.22	47.64	7.14	3.05	.44	13468	14696
11	13.28	40.58	37.71	8.43	3.04	.60	11435	------------
	Dry	46.80	43.48	9.72	3.51	.69	13186	14896
Average	15.10	39.06	38.68	7.16	2.79	.48	11315	------------
	Dry	46.01	45.56	8.43	3.28	.56	13327	14796

EXTRA SAMPLE—LA SALLE CO., NO. 5 COAL

	14.76	41.33	34.26	9.65	3.38	.61	10692	------------
	Dry	48.49	40.19	11.32	3.97	.71	12543	14397

DISTRICT NO. 1—LIVINGSTON CO., NO. 5 COAL

215	9.40	35.69	41.09	13.80	4.74	----------	11258	------------
	Dry	40.05	45.35	15.26	5.24	----------	12422	15084
216	13.76	36.00	38.96	11.50	3.15	----------	10850	------------
	Dry	41.48	45.18	13.34	3.66	----------	12581	14836
Average	11.58	35.84	40.02	12.65	3.94	----------	11054	------------
	Dry	40.26	45.26	14.30	4.45	----------	12501	14960

DISTRICT No. 1—LA SALLE CO., NO. 7 COAL

99	13.56	40.87	37.80	7.77	3.68	.17	11347	------------
	Dry	47.28	43.73	8.99	4.26	.20	13127	14685

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—**Continued.**

DISTRICT NO. 2—JACKSON CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
12	9.62	33.02	51.09	6.27	1.13	.69	12260	------------
	Dry	36.53	56.53	6.94	1.25	.76	13565	14705
13	10.18	33.40	51.90	4.52	.97	.29	12614	------------
	Dry	37.18	57.79	5.03	1.08	.32	14044	14888
14	8.56	34.18	50.25	7.01	1.54	.09	12418	------------
	Dry	37.39	54.95	7.66	1.68	.10	13581	14864
15	8.70	34.77	51.34	5.19	1.42	.09	12651	------------
	Dry	38.08	56.23	5.69	1.55	.12	13856	14815
16	9.34	34.55	50.52	5.59	1.40	.26	12490	------------
	Dry	38.11	55.72	6.17	1.54	.29	13777	14820
104	4.56	36.32	45.22	13.90	7.12	.03	11778	------------
	Dry	38.06	47.38	14.57	7.47	.03	12167	14927
Average	8.49	34.37	50.05	7.08	2.26	.24	12368	------------
	Dry	37.55	54.76	7.67	2.42	.27	13498	14836

DISTRICT NO. 3—CHRISTIAN CO., NO. 1 COAL

21	11.31	38.89	40.94	8.86	2.35	.43	11602	------------
	Dry	43.85	46.16	9.99	2.65	.48	13081	14717

DISTRICT NO. 3—FULTON CO., NO. 1 COAL

105	11.21	38.41	40.16	10.20	4.96	.62	11466	------------
	Dry	43.26	45.23	11.50	5.58	.70	12914	14950

DISTRICT NO. 3—MERCER CO., NO. 1 COAL

17	17.63	39.13	34.13	9.11	5.02	.70	10336	------------
	Dry	47.51	41.44	11.05	6.09	.85	12548	14373
18	14.58	39.07	37.00	9.35	4.79	.21	10880	------------
	Dry	45.74	43.31	10.95	5.61	.25	12737	14640
19	14.52	39.26	36.32	9.90	4.24	.68	10809	------------
	Dry	45.93	42.49	11.58	4.96	.80	12645	14624
Average	15.58	39.17	35.80	9.45	4.69	.53	10673	------
	Dry	46.40	42.41	11.19	5.55	.63	12643	14546

DISTRICT NO. 3—McDONOUGH CO., NO. 2 COAL

22	17.40	33.30	41.47	7.82	2.02	.27	10811	------------
	Dry	40.31	50.23	9.48	2.45	.33	13091	14663
213	15.86	35.08	40.27	8.79	3.86	----------	10798	------------
	Dry	41.69	47.85	10.45	4.58	----------	12832	14621
Average	16.63	34.19	40.37	8.31	2.94	----------	10804	------------
	Dry	41.00	49.04	9.96	3.51	----------	12961	14642

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 3—SCHUYLER CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
214	14.53	37.83	42.08	7.54	4.54	----------	11731	----------
	Dry	43.26	48.11	8.62	5.19	----------	13411	14967

DISTRICT NO. 4—McLEAN CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
100	11.26	42.21	37.73	8.80	3.03	.98	11566	----------
	Dry	47.57	42.52	9.91	3.41	1.10	13034	14714
B. M. 55	10.06	35.93	39.16	14.83	2.97	----------	11149	----------
	Dry	39.95	43.55	16.49	3.31	----------	12422	15028
Average	10.66	39.07	38.44	11.81	3.00	----------	11357	----------
	Dry	43.76	43.03	13.20	3.36	----------	12728	14871

DISTRICT NO. 4—FULTON CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
28	16.68	36.68	36.76	9.88	2.90	1.36	10375	----------
	Dry	44.02	44.12	11.86	3.48	1.63	12452	14403
29	16.38	35.96	36.88	10.78	3.47	1.02	10230	----------
	Dry	43.01	44.10	12.89	4.15	1.22	12234	14349
30	16.18	35.17	37.77	10.88	3.06	1.53	10296	----------
	Dry	41.96	45.06	12.98	3.65	1.82	12284	14402
31	16.88	36.32	36.32	10.48	2.98	1.25	10269	----------
	Dry	43.70	43.70	12.61	3.58	1.50	12355	14424
32	14.66	37.24	37.71	10.39	3.28	1.54	10651	----------
	Dry	43.64	44.18	12.18	3.84	1.81	12481	14502
110	15.43	33.62	39.47	11.48	2.50	1.41	10389	----------
	Dry	39.76	46.67	13.57	2.66	1.67	12285	14473
111	14.61	34.05	38.64	13.22	3.03	2.22	10130	----------
	Dry	39.88	46.25	14.86	3.55	2.60	11865	14289
112	15.26	35.88	38.61	11.12	2.79	1.54	10522	----------
	Dry	41.30	45.56	13.12	3.29	1.78	12818	14596
113	14.25	34.79	39.19	11.75	3.18	1.45	10622	----------
	Dry	40.57	45.71	13.71	3.71	1.69	12383	14656
114	14.81	35.86	38.43	10.88	2.89	1.60	10123	----------
	Dry	37.10	45.11	12.78	3.40	1.87	12265	14339
115	15.25	33.50	40.50	10.25	3.10	1.16	10610	----------
	Dry	39.50	47.80	12.70	3.70	1.37	12520	14580
116	15.69	35.03	38.29	10.97	3.88	.51	10467	----------
	Dry	41.55	45.43	13.01	4.61	.61	12416	14609
117	13.5	34.4	38.8	13.3	3.5	----------	10410	----------
	Dry	39.8	44.8	15.4	4.1	----------	12040	14589
118	12.78	38.60	30.32	11.53	3.80	1.03	10903	----------
	Dry	40.40	49.66	13.26	4.36	1.18	12296	14746
Average	15.88	35.50	37.68	11.40	3.16	1.35	10428	----------
	Dry	41.15	45.58	13.53	3.72	1.58	12335	14496

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 4—LOGAN CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
33	14.20	37.19	37.44	11.37	3.34	1.42	10490	------------
	Dry	43.35	43.40	13.25	3.89	1.66	12226	14400
109	13.53	35.58	40.82	10.06	2.95	1.05	10924	------------
	Dry	41.14	47.20	11.64	3.09	1.15	12633	14590
B. M. 37	15.32	32.52	39.81	12.34	3.70	----------	10371	------------
	Dry	38.41	47.01	14.57	4.37	----------	12234	14671
Average	14.35	35.09	39.35	11.25	3.33	1.23	10595	------------
	Dry	37.96	45.87	13.15	3.78	1.40	12364	14553

DISTRICT NO. 4—MACON CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
41	14.48	36.00	38.05	11.47	3.32	.90	10445	------------
	Dry	42.10	44.49	13.41	3.88	1 05	12214	14420
42	13.83	37.35	39.62	9.20	3.83	.09	10877	------------
	Dry	43.34	45.98	10.68	4.45	.11	12623	14418
123	12.82	35.45	43.07	8.64	3.23	.13	11010	------------
	Dry	40.67	49.41	9.91	3.71	.15	12668	14305
Average	13.71	36.26	40.24	9.77	3.46	.37	10777	------------
	Dry	42.03	46.62	11.33	4.01	.43	12501	14381

DISTRICT NO. 4—McLEAN CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
100	13.32	38.00	36.21	12.47	3.73	1.20	10580	------------
	Dry	43.84	41.78	14.38	4.30	1.39	12206	14604

DISTRICT NO. 4—MENARD CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
34	17.33	35.88	38.62	8.17	3.44	.50	10499	------------
	Dry	43.40	46.72	9.88	4.16	.60	12700	14478

DISTRICT NO. 4—PEORIA CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
25	14.92	36.92	37.21	11.02	3.44	1.21	10951	------------
	Dry	43.30	43.74	12.95	4.04	1.42	12448	14614
26	15.00	36.48	36.75	11.77	3.08	1.80	10421	------------
	Dry	42.91	43.24	13.85	3.62	2.12	12260	14614
106	13.40	30.33	44.80	11.46	3.80	1.05	10736	------------
	Dry	35.03	51.76	13.20	4.40	1.20	11980	14670
107	10.73	34.56	39.96	11.36	2.96	1.77	10673	------------
	Dry	40.16	46.60	13.23	3.40	2.05	12423	14617
B. M. 2	15.45	32.05	40.11	14.54	3.84	----------	10732	------------
	Dry	40.87	47.45	17.18	4.29	----------	12693	14687
B. M. 3	15.38	34.34	38.65	11.63	2.90	----------	10414	------------
	Dry	40.58	45.65	13.74	3.43	----------	12415	14575
Average	14.14	34.11	39.58	11.96	3.33	1.45	10654	------------
	Dry	40.47	46.40	14.02	3.86	1.69	12369	14629

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 4—SANGAMON CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
36	15.34	36.54	37.83	10.29	3.67	.59	10519	------------
	Dry	43.16	44.68	12.16	4.33	.70	12425	14450
37	13.78	37.82	37.69	10.73	4.11	.47	10625	------------
	Dry	43.86	43.71	12.44	4.77	.55	12323	14396
38	14.26	38.07	37.48	10.19	4.14	.37	10649	------------
	Dry	44.40	43.71	11.89	4.83	.43	12420	14410
39	13.31	37.43	36.66	12.60	4.72	.94	10398	------------
	Dry	43.17	42.29	14.54	5.45	1.09	11995	14420
40	15.06	36.69	38.15	10.10	4.08	.59	10584	------------
	Dry	43.19	44.92	11.89	4.80	.69	12460	14403
119	14.06	35.85	39.54	10.54	3.74	.43	10686	------------
	Dry	41.71	46.01	12.26	4.31	.50	12434	14479
120	13.62	36.81	39.24	10.32	3.93	.79	10786	------------
	Dry	42.62	45.42	11.95	4.55	.92	12487	14452
121	10.73	34.55	40.77	10.28	3.75	.45	10741	------------
	Dry	40.30	47.83	11.96	4.37	.52	12491	14502
122	13.15	35.62	41.28	9.93	3.90	.62	10812	------------
	Dry	41.02	47.54	11.44	4.49	.72	12449	14434
B. M. 41	13.70	34.47	40.58	11.23	3.81	------------	10696	------------
	Dry	39.95	47.03	13.01	4.42	------------	12332	13969
Average	13.70	36.38	38.92	10.62	3.98	.51	10650	------------
	Dry	42.33	45.31	12.32	4.63	.68	12381	14391

DISTRICT NO. 4—TAZEWELL CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
27	14.38	37.74	38.23	9.66	3.10	1.20	10809	------------
	Dry	44.08	44.65	11.28	3.62	1.40	12624	14496
108	15.76	34.36	40.60	9.26	3.30	.75	10660	------------
	Dry	40.80	48.23	10.76	3.90	.89	12656	14764
Average	15.07	36.05	39.41	9.46	3.20	.97	10734	------------
	Dry	42.44	46.44	11.02	3.76	1.14	12640	14630

DISTRICT NO. 5—GALLATIN CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
47	5.72	35.77	46.71	11.80	3.47	1.01	12053	------------
	Dry	37.94	49.54	12.52	3.68	1.07	12784	14919
Extra	4.13	34.21	52.80	8.86	3.23	.02	12987	------------
	Dry	35.68	55.07	9.25	3.37	03	13546	15175
135	3.96	35.38	50.23	10.41	3.37	.25	12601	------------
	Dry	36.84	52.31	10.85	3.51	.26	12997	14997
Average	4.60	35.12	49.91	10.36	3.36	.43	12547	------------
	Dry	36.82	52.31	10.87	3.52	.45	13309	15030

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 5—SALINE CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO$_2$	B. t. u.	"Unit coal"
43	6.97	35.98	49.69	7.36	2.05	.32	12550	------------
	Dry	38.68	53.41	7.92	2.20	.34	13490	14829
44	6.70	35.31	49.55	8.44	2.56	.02	12401	------------
	Dry	37.85	53.11	9.04	2.74	.02	13291	14824
45	7.03	34.78	50.27	7.92	2.48	.26	12420	------------
	Dry	37.41	54.07	8.52	2.67	.28	13359	14806
46	7.96	34.68	48.54	8.82	2.79	.46	12077	------------
	Dry	37.68	52.74	9.58	3.03	.50	13122	14741
48	7.67	33.90	50.26	8.17	2.56	.70	12234	------------
	Dry	36.72	54.43	8.85	2.77	.76	13250	14739
49	5.20	38.06	45.90	10.84	4.60	.59	12193	------------
	Dry	40.15	48.42	11.43	4.85	.62	12862	14824
124	6.83	33.25	51.85	8.03	2.24	.22	12435	------------
	Dry	35.70	55.67	8.62	2.40	.23	13353	14806
125	6.59	33.50	52.08	7.82	2.37	.09	12526	------------
	Dry	35.87	55.75	8.37	2.54	.09	13743	14831
126	6.01	34.05	52.34	7.58	2.56	.16	12582	------------
	Dry	36.23	55.70	8.06	2.61	.16	13341	14784
127	5.68	33.78	52.85	7.94	2.13	.42	12614	------------
	Dry	35.82	55.75	8.42	2.26	.44	13708	14780
128	6.51	32.24	51.31	9.93	1.87	.06	12175	------------
	Dry	34.48	54.87	10.63	2.01	.06	13022	14782
129	5.98	34.17	52.82	7.02	2.01	.09	12715	------------
	Dry	36.34	56.21	7.47	2.17	.09	13524	14840
130	6.22	33.33	51.47	8.96	2.71	.16	12339	------------
	Dry	35.54	54.89	9.56	2.83	.17	13358	14772
B. M. 5	7.61	32.64	51.65	8.24	2.08	----------	12225	------------
	Dry	35.05	55.99	8.95	2.22	----------	13316	15208
B. M. 6	5.78	33.39	52.81	8.01	2.26	----------	12718	------------
	Dry	35.44	56.06	8.50	2.72	----------	13498	15120
B. M. 7	7.07	34.56	51.07	7.29	2.15	----------	12560	------------
	Dry	37.19	54.95	7.85	2.31	----------	13516	15120
B. M. 8	4.83	38.49	46.74	9.73	4.03	----------	12441	------------
	Dry	40.65	49.12	10.22	4.23	----------	13073	14842
Average	6.08	34.37	51.05	8.47	2.83	.22	12521	------------
	Dry	36.61	54.36	9.02	2.96	.24	13377	14922

DISTRICT NO. 5—GALLATIN CO., NO. 6 COAL

Extra	7.54	34.96	45.68	11.82	4.34	.23	11916	------------
	Dry	37.81	49.41	12.78	4.70	.25	12888	15136
223	7.04	34.97	48.15	8.83	4.37	.03	12394	------------
	Dry	38.38	51.82	9.79	4.72	.03	13677	15095
Average	7.29	34.96	46.91	10.33	4.36	.13	12155	------------
	Dry	38.09	50.61	11.29	4.71	.14	13283	15115

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

EXTRA SAMPLE—GALLATIN CO., COAL MARKED "BELL"

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
	3.40	33.33	55.18	8.09	4.25	.03	13401	------------
	Dry	34.50	57.12	8.38	4.40	.03	13872	15420

DISTRICT NO. 5—WHITE CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
228	8.36	35.24	47.43	8.89	2.85	.64	11923	------------
	Dry	38.49	51.80	9.71	3.11	.69	13022	14654

DISTRICT NO. 6—FRANKLIN CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
50	9.34	34.84	48.03	7.79	1.04	.38	12004	------------
	Dry	38.42	52.99	8.59	1.15	.42	13241	14633
51	10.28	33.42	49.05	7.25	1.18	.10	11890	------------
	Dry	37.26	54.66	8.08	1.32	.11	13252	14562
52	6.77	38.35	44.62	10.26	3.13	.91	11875	------------
	Dry	41.14	47.85	11.00	3.36	.98	12737	14554
53	10.18	32.78	48.88	8.16	.64	.61	11661	------------
	Dry	36.50	54.41	9.09	.71	.68	12983	14419
56	8.10	36.30	45.34	10.26	2.51	.74	11826	------------
	Dry	39.50	49.34	11.16	2.73	.80	12758	14601
57	9.67	35.69	49.55	8.54	.95	.32	11756	------------
	Dry	32.24	54.86	9.45	1.05	.35	13015	14529
58	8.93	34.51	48.80	7.76	.74	.36	11937	------------
	Dry	37.89	53.59	8.52	.81	.40	13108	14463
134	8.28	33.23	47.34	8.80	1.26	.20	11962	------------
	Dry	36.22	54.17	9.59	1.38	.22	12885	14487
136	7.37	35.16	47.39	9.66	2.50	.37	11757	------------
	Dry	37.98	51.57	10.43	2.72	.40	12602	14433
137	10.21	34.29	47.70	7.79	.79	----------	11813	------------
	Dry	35.67	53.13	8.65	.88	----------	13155	14556
138	9.84	34.30	47.93	7.91	.76	----------	11824	------------
	Dry	39.09	53.16	8.78	.84	----------	13113	14392
139	7.87	35.15	47.60	9.36	2.28	.22	11790	------------
	Dry	38.14	51.70	10.14	2.47	.24	14351	14461
140	6.84	35.05	49.22	8.87	2.54	.18	11964	------------
	Dry	37.61	52.86	9.52	2.71	.19	12708	14412
141	10.19	33.35	48.66	7.79	1.11	----------	11824	------------
	Dry	37.14	54.18	8.68	1.50	----------	13166	14632
142	9.98	32.72	49.20	8.09	.83	----------	11903	------------
	Dry	36.34	54.66	8.98	.92	----------	13224	14675
143	10.18	34.19	48.54	7.12	1.30	----------	11936	------------
	Dry	36.74	54.04	7.92	1.44	----------	12827	14700
144	10.46	32.35	49.66	7.51	.73	----------	11807	------------
	Dry	36.13	55.47	8.38	.82	----------	13216	14550
145	8.48	32.16	50.88	8.46	1.03	.16	11917	------------
	Dry	35.16	55.45	9.24	1.13	.17	12969	14503

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 6—FRANKLIN CO., NO. 6 COAL—Concluded.

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
146	9.28	31.39	50.06	9.27	.69	----------	11908	------------
	Dry	38.84	55.18	10.21	.76	----------	12962	14558
147	8.42	33.91	46.45	10.20	3.27	----------	11569	------------
	Dry	37.43	51.29	11.25	3.61	----------	12773	14649
B. M. 9	9.35	32.41	49.39	8.84	1.41	----------	11858	------------
	Dry	35.76	52.92	9.75	1.55	----------	13016	14686
B. M. 10	8.61	33.69	48.47	9.21	1.09	----------	11921	------------
	Dry	36.87	53.04	10.07	1.19	----------	13020	14688
B. M. 11	9.50	31.98	47.08	11.44	1.45	----------	11506	------------
	Dry	35.34	52.02	12.64	1.60	----------	12713	14780
B. M. 12	10.63	28.83	52.03	8.48	5.53	----------	11585	------------
	Dry	32.26	58.24	9.49	6.20	----------	12734	14909
B. M. 13	9.00	34.27	48.08	8.64	1.06	----------	11980	------------
	Dry	37.66	52.83	9.50	1.17	----------	13165	14712
B. M. 14	9.18	33.93	48.51	8.36	.92	----------	11911	------------
	Dry	37.36	53.42	9.37	1.01	----------	13116	14620
B. M. 15	9.96	32.86	49.06	8.11	.80	----------	11901	------------
	Dry	36.49	54.49	9.01	.89	----------	13215	14672
B. M. 16	7.14	30.69	50.47	9.27	.51	----------	11727	------------
	Dry	33.93	55.80	10.26	.57	----------	12964	14602
B. M. 17	8.99	32.21	49.75	9.29	.88	----------	11788	------------
	Dry	35.39	54.40	11.94	.97	----------	12953	14673
B. M. 18	9.83	32.76	49.52	7.87	1.00	----------	11901	------------
	Dry	36.34	54.93	8.73	1.11	----------	13199	14609
B. M. 19	10.21	32.45	49.33	8.01	1.02	----------	11152	------------
	Dry	36.13	54.94	8.92	1.18	----------	13162	14605
B. M. 20	8.25	31.30	49.65	10.79	1.08	----------	11645	------------
	Dry	34.11	54.12	11.76	1.18	----------	12128	14580
B. M. 21	9.84	34.58	47.93	7.91	.76	----------	11824	------------
	Dry	38.04	53.16	8.78	.84	----------	13113	14514
B. M. 22	9.58	33.58	48.20	8.63	1.09	----------	11866	------------
	Dry	37.14	53.31	9.54	1.21	----------	13125	14640
B. M. 58	8.33	34.91	48.45	8.29	1.09	----------	12050	------------
	Dry	38.07	52.87	9.05	1.18	----------	13146	14618
Average	9.11	33.53	48.59	8.68	1.39	.37	11815	------------
	Dry	36.75	53.57	9.61	1.54	.41	13023	14590

DISTRICT NO. 6—JACKSON CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
55	8.96	34.44	46.40	10.20	2.65	.40	11609	------------
	Dry	37.83	50.97	11.20	2.91	.44	12751	14608
183	9.74	34.58	46.62	9.34	1.43	.14	11467	------------
	Dry	38.32	51.58	10.28	1.58	.15	12693	14343
Average	9.35	34.51	46.51	9.77	2.04	.27	11538	------------
	Dry	38.07	51.27	10.74	2.24	.29	12722	14475

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 6—PERRY CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
54	9.92	32.72	46.97	10.39	.92	.25	11335	------------
	Dry	36.81	52.15	11.53	1.02	.28	12583	14407
175	10.14	35.64	43.76	10.45	3.66	.36	11356	------------
	Dry	39.67	48.70	11.63	4.08	.40	12455	14379
178	9.77	34.99	42.19	12.70	4.09	.32	10815	------------
	Dry	38.78	47.13	14.06	4.54	.34	11987	14330
179	8.83	37.36	43.02	10.78	3.40	.12	11295	------------
	Dry	40.99	47.18	11.82	3.73	.13	12202	14327
180	9.31	33.64	47.51	9.52	1.07	.20	11596	------------
	Dry	37.10	52.39	10.50	1.18	.23	12278	14337
181	12.08	33.81	44.87	9.22	.99	----------	11227	------------
	Dry	38.46	51.04	10.49	1.69	----------	12769	14446
B. M. 29	10.96	32.52	48.64	7.86	.85	----------	11542	------------
	Dry	36.53	54.63	8.83	.96	----------	12963	14365
Average	10.14	34.38	45.28	10.13	2.14	.25	11309	------------
	Dry	38.33	50.46	11.26	2.45	.27	12462	14370

DISTRICT NO. 6—WILLIAMSON CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
59	10.47	32.99	47.27	9.27	1.52	.38	11630	------------
	Dry	36.85	52.80	10.35	1.70	.43	12990	14684
60	8.22	34.00	48.79	8.99	2.16	.33	11959	------------
	Dry	37.04	53.16	9.80	2.35	.36	13030	14660
61	9.27	33.83	49.70	7.20	1.37	.13	12127	------------
	Dry	37.28	54.78	7.94	1.51	.14	13366	14671
62	9.13	33.09	49.94	7.84	1.17	.22	12028	------------
	Dry	36.42	54.95	8.63	1.29	.24	13236	14637
63	9.47	33.45	48.13	8.95	1.94	.36	11852	------------
	Dry	36.96	53.16	9.88	2.14	.40	13092	14730
64	9.34	32.77	49.48	8.41	.92	.52	11872	------------
	Dry	36.15	54.58	9.27	1.01	.57	13095	14577
65	9.31	33.52	48.98	8.19	1.70	.13	11919	------------
	Dry	36.96	54.01	9.03	1.88	.14	13143	14627
148	7.99	33.48	50.15	8.37	1.21	.15	12129	------------
	Dry	36.39	54.51	9.09	1.32	.16	13183	14664
149	6.31	35.09	47.86	10.73	3.08	.43	11931	------------
	Dry	37.45	51.11	11.43	3.28	.49	12738	14697
150	5.98	35.00	47.69	11.29	4.00	.26	11786	------------
	Dry	37.23	50.72	12.01	4.25	.27	12536	14550
151	6.91	36.41	47.09	9.59	2.78	.10	12015	------------
	Dry	39.11	50.58	10.30	2.99	.11	12907	14625
152	7.03	32.26	51.63	9.07	1.32	.31	12117	------------
	Dry	34.70	55.53	9.75	1.42	.33	13009	14617
153	9.63	32.30	49.54	8.52	.91	----------	11824	------------
	Dry	37.49	54.83	9.43	1.01	----------	13086	14607
154	7.90	32.28	51.29	8.52	1.19	.17	12108	------------
	Dry	35.05	55.70	9.24	1.29	.19	13129	14530
155	8.21	32.75	51.09	7.94	1.18	.14	12017	------------
	Dry	35.67	55.66	8.66	1.29	.16	13043	14485
156	8.24	32.91	52.98	7.05	1.40	.12	12150	------------
	Dry	34.56	57.74	7.28	1.54	.13	13202	14448

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 6—WILLIAMSON CO., NO. 6 COAL—Concluded.

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
157	8.20	34.51	48.33	8.95	2.50	.24	12007	
	Dry	37.59	52.67	9.74	2.71	.25	13081	14718
158	8.54	31.07	51.88	8.50	2.22	.17	11861	
	Dry	33.97	56.73	9.29	2.42	.18	12892	14535
159	7.59	33.59	50.40	9.74	3.11	.13	11880	
	Dry	34.90	54.54	10.54	3.36	.14	12720	14625
160	8.07	32.59	50.70	8.64	2.14	.05	11966	
	Dry	35.44	55.16	9.39	2.32	.05	12900	14564
161	9.07	33.00	49.84	8.08	.98		11923	
	Dry	36.30	54.81	8.88	1.08		13115	14539
162	9.90	33.23	48.10	8.77	1.27		11716	
	Dry	36.88	53.38	9.74	1.41		13003	14579
163	6.62	34.97	47.61	10.75	3.16		11875	
	Dry	37.92	51.17	11.52	3.28		12702	14624
164	7.31	34.18	46.48	12.02	3.07		11635	
	Dry	36.88	50.15	12.97	3.31		12553	14726
165	8.04	33.04	49.10	9.81	2.24	.70	11854	
	Dry	35.92	53.42	10.65	2.42	.76	12893	14655
166	7.46	32.79	49.32	10.41	2.86	.55	11733	
	Dry	35.44	53.31	11.24	3.05	.60	12529	14540
167	7.78	32.75	50.34	9.11	1.88	.27	11925	
	Dry	35.50	54.60	9.88	2.03	.29	12858	14550
168	5.22	36.59	46.09	12.08	3.55	.36	11909	
	Dry	38.60	48.63	12.75	3.76	.38	12450	14707
169	6.10	35.44	47.27	11.18	3.85	.36	11786	
	Dry	37.74	50.35	11.91	4.11	.38	12414	14553
170	6.40	36.71	47.70	9.19	3.41	.04	12150	
	Dry	39.22	50.96	9.82	3.64	.04	12981	14644
171	7.29	34.93	47.65	10.13	3.78	.04	11745	
	Dry	37.68	51.39	10.93	4.08	.04	12669	14334
172	6.40	36.38	48.20	9.02	3.45	.04	12179	
	Dry	38.87	51.49	9.64	3.69	.04	13012	14648
173	6.95	36.05	45.33	11.65	3.54	.52	11744	
	Dry	38.75	48.73	12.51	3.81	.56	12623	14787
174	6.93	33.52	50.04	9.49	2.03		12039	
	Dry	36.02	53.77	10.20	2.18		12934	14610
B. M. 23	11.44	30.82	46.70	11.02	2.82		11191	
	Dry	34.77	52.79	12.43	3.17		12708	12275
B. M. 24	9.89	31.30	50.62	9.52	1.79		11983	
	Dry	34.22	55.38	10.40	2.23		13085	14815
B. M. 25	8.65	30.20	52.99	8.17	1.23		12079	
	Dry	33.06	58.01	8.92	1.34		13220	14725
B. M. 26	7.78	31.81	51.75	8.65	1.58		12081	
	Dry	34.49	53.20	9.39	1.71		13129	14779
B. M. 27	8.94	32.41	50.97	7.66	1.26		12112	
	Dry	35.56	55.98	8.41	1.39		13303	14679
B. M. 28	9.07	33.00	49.84	8.18	.98		11923	
	Dry	36.30	54.81	8.88	1.08		13073	14507
Average	8.07	33.52	50.12	9.26	2.17	.25	11549	
	Dry	36.43	53.48	10.05	2.34	.27	12940	14463

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 7—BOND CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
218	11.96	35.09	42.31	10.30	3.38	.66	10806	------------
	Dry	39.86	48.06	12.07	3.84	.70	12274	14240

DISTRICT NO. 7—CHRISTIAN CO., NO. 1 COAL

21	11.31	38.89	40.94	8.86	2.35	.43	11602	------------
	Dry	43.85	46.16	9.99	2.65	.48	13081	14717

DISTRICT NO. 7—CHRISTIAN CO., NO. 2 COAL

21	12.96	38.96	40.94	6.92	3.13	.20	11591	------------
	Dry	45.01	47.04	7.95	3.60	.24	13319	14691

DISTRICT NO. 7—CHRISTIAN CO., NO. 6 COAL

219	12.00	37.22	39.77	11.01	3.85	.45	10798	------------
	Dry	42.29	45.19	12.51	4.38	.51	12271	14455
220	13.91	36.39	39.32	10.36	4.00	.54	10682	------------
	Dry	42.28	45.68	12.02	4.65	.63	12410	14493
221	12.04	37.09	40.60	10.25	4.17	.22	10887	------------
	Dry	42.17	46.16	11.66	4.74	.26	12438	14293
222	12.10	37.64	41.00	9.17	3.71	.11	11043	------------
	Dry	42.83	46.73	10.43	4.22	.13	12565	13917
B. M. 56	12.67	37.27	39.44	10.55	3.65	----------	10919	------------
	Dry	42.75	45.17	12.08	4.38	----------	12504	14442
Average	12.54	37.12	40.03	10.27	3.89	.33	10866	------------
	Dry	42.46	45.79	11.74	4.47	.38	12438	14320

DISTRICT NO. 7—CLINTON CO., NO. 6 COAL

84	12.86	37.26	39.53	10.35	4.26	.58	10755	------------
	Dry	42.76	45.36	11.88	4.89	.66	12342	14335
85	12.39	36.88	40.68	10.05	3.52	.72	10836	------------
	Dry	42.10	46.43	11.47	4.02	.82	12368	14245
198	11.09	36.99	41.04	10.86	3.51	.61	10887	------------
	Dry	41.61	46.17	12.21	3.95	.69	12242	14450
199	11.17	34.93	43.26	10.64	3.58	.44	10920	------------
	Dry	39.32	48.69	11.98	4.03	.50	12294	13853
B. M. 46	11.71	35.21	42.63	10.44	4.06	----------	11011	------------
	Dry	39.88	48.29	11.82	4.59	----------	12441	14363
B. M. 47	12.53	33.43	44.20	9.83	3.96	----------	10947	------------
	Dry	38.15	50.55	11.23	4.52	----------	12503	14801
B. M. 48	14.75	29.62	45.98	9.64	1.57	----------	10726	------------
	Dry	34.75	53.94	11.31	1.84	----------	12629	14447
Average	12.35	34.90	42.47	10.25	3.49	.58	10871	------------
	Dry	39.79	48.49	13.12	3.97	.66	12402	14356

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 7—MACOUPIN CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
66	14.26	38.70	37.07	9.97	4.34	.41	10549	------------
	Dry	45.14	43.24	11.62	5.06	.48	12304	14236
67	14.19	37.48	38.24	9.99	3.92	.33	10558	------------
	Dry	43.68	44.57	11.75	4.57	.39	12447	14408
68	12.87	39.24	38.73	9.16	4.56	.30	10964	------------
	Dry	45.04	44.45	10.51	5.23	.35	12583	14365
69	14.20	37.40	36.95	11.45	4.42	.29	10438	------------
	Dry	43.59	43.06	13.35	5.15	.34	12165	14388
185	11.85	39.35	39.77	9.01	3.49	.28	11069	------------
	Dry	44.62	45.14	10.23	3.96	.32	12557	14243
186	10.78	37.82	40.56	10.49	4.00	.66	10906	------------
	Dry	42.54	45.64	11.81	4.50	.74	12271	14208
187	13.56	36.74	38.83	10.80	4.19	.40	10549	------------
	Dry	42.51	44.92	12.57	4.85	.47	12203	14279
188	11.97	38.65	40.90	8.42	3.93	.14	11061	------------
	Dry	43.91	46.50	9.57	4.46	.16	12566	14189
189	13.93	35.12	42.04	8.89	3.78	.11	11012	------------
	Dry	40.80	48.85	10.34	4.39	.13	12407	14129
190	14.11	34.23	42.42	9.23	3.63	.15	10709	------------
	Dry	39.86	49.39	10.74	4.22	.18	12466	14191
228	14.03	37.17	39.60	9.20	3.49	----------	10753	------------
	Dry	43.24	46.06	10.70	4.06	----------	12508	14273
B. M. 30	14.29	34.18	40.16	11.36	3.91	----------	10536	------------
	Dry	39.86	46.86	13.27	4.57	----------	12260	14558
B. M. 31	14.25	36.85	39.20	10.68	4.21	----------	10632	------------
	Dry	42.48	45.20	12.31	4.85	----------	12258	14298
Average	13.36	37.32	39.58	9.92	4.01	.30	10752	------------
	Dry	42.86	45.42	11.46	4.63	.35	12380	14290

DISTRICT NO. 7—MADISON CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
70	12.81	38.67	37.40	11.12	4.80	.44	10661	------------
	Dry	44.35	42.91	12.75	5.51	.54	12227	14365
71	12.52	39.55	37.51	10.42	4.09	.61	10871	------------
	Dry	45.21	42.88	11.91	4.68	.70	12427	14421
72	13.82	37.54	38.94	9.70	4.25	.25	10722	------------
	Dry	43.56	45.19	11.25	4.93	.29	12441	14391
73	14.71	38.61	38.22	8.46	3.76	.28	10785	------------
	Dry	45.27	44.81	9.92	4.41	.33	12645	14305
191	12.97	38.33	37.82	10.86	3.69	.51	10708	------------
	Dry	44.05	43.46	12.47	4.24	.59	12305	14362
192	11.64	37.02	41.06	10.27	4.04	.44	10963	------------
	Dry	41.89	46.47	11.62	4.57	.50	12407	14511
B. M. 32	12.69	35.12	36.14	14.04	4.32	----------	10232	------------
	Dry	40.19	43.68	15.80	4.94	----------	11750	14619
B. M. 33	10.69	33.08	36.14	20.09	4.06	----------	9713	------------
	Dry	37.04	40.47	22.49	4.55	----------	10876	14560
B. M. 34	13.25	34.03	40.09	12.11	3.98	----------	10371	------------
	Dry	39.44	46.47	14.08	4.61	----------	12057	14448

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 7—MADISON CO., NO. 6 COAL—Concluded.

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
B. M.	12.95	34.11	41.11	11.81	4.06	----------	10699	------------
35	Dry	39.19	47.23	13.57	4.66	----------	12292	14565
B. M.	13.07	34.27	40.79	11.86	4.45	----------	10562	------------
36	Dry	39.42	46.93	13.64	5.11	----------	12115	14532
B. M.	15.09	31.00	46.49	7.42	.83	----------	11151	------------
38	Dry	36.51	54.75	8.74	.98	----------	13133	14533
B. M.	15.19	31.02	43.41	10.36	1.44	----------	10737	------------
39	Dry	36.57	51.19	12.23	1.70	----------	12567	14526
B. M.	12.69	36.50	41.45	9.35	3.72	----------	11025	------------
40	Dry	41.80	47.76	10.71	4.05	----------	12627	14466
Average	13.14	35.63	44.31	12.50	3.67	.42	10657	------------
	Dry	41.03	46.01	12.94	4.21	.49	12276	14471

DISTRICT NO. 7—MARION CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
87	10.46	36.85	41.53	11.16	4.01	.42	11174	------------
	Dry	41.15	46.38	12.47	4.48	.47	12480	14574
206	9.93	36.45	42.22	11.38	4.06	.31	11168	------------
	Dry	40.47	46.89	12.63	4.50	.34	12401	14582
207	10.41	36.71	42.31	10.56	3.27	.43	11267	------------
	Dry	40.98	47.22	11.79	3.65	.49	12576	14536
B. M.	10.69	36.01	41.76	11.53	3.60	----------	11018	------------
52	Dry	40.32	46.78	12.89	4.03	----------	12257	14650
Average	10.37	36.50	41.95	11.15	3.96	.29	11156	------------
	Dry	40.75	46.81	12.44	4.16	.32	12428	14585

DISTRICT NO. 7—MONTGOMERY CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
76	13.89	37.05	38.44	10.62	3.85	.94	10574	------------
	Dry	43.04	44.64	12.32	4.47	1.10	12280	14312
77	14.40	36.70	39.84	9.06	3.83	.49	10709	------------
	Dry	42.88	46.54	10.58	4.47	.57	12511	14268
194	13.19	36.30	40.62	9.68	4.07	.49	10779	------------
	Dry	41.81	47.03	11.15	4.69	.57	12418	14270
195	12.87	36.07	41.61	9.44	3.83	.45	10844	------------
	Dry	41.39	47.77	10.83	4.40	.51	12447	14348
196	12.27	36.79	40.62	10.45	4.42	.73	10799	------------
	Dry	41.87	46.23	11.89	5.04	.83	12296	14271
197	14.71	34.67	41.79	8.79	3.85	.42	10588	------------
	Dry	40.66	49.01	10.32	4.51	.49	12415	14113
B. M.	13.54	38.85	42.09	11.64	3.99	----------	10550	------------
43	Dry	44.47	48.69	13.45	4.61	----------	12195	14453
B. M.	13.17	33.64	41.34	11.83	----------	----------	10548	------------
44	Dry	38.75	47.62	13.62	----------	----------	12168	14394
B. M.	13.47	34.62	40.32	11.57	3.47	----------	10558	------------
45	Dry	40.01	46.60	13.37	4.64	----------	12202	14417
Average	13.50	34.96	40.74	10.34	3.91	.58	10661	------------
	Dry	41.65	47.12	11.94	4.60	.67	12325	14316

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 7—MOULTRIE CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
225	6.83	39.15	42.31	11.37	4.01	.57	11878	------------
	Dry	42.01	45.41	12.56	4.31	.61	12738	14882

DISTRICT NO. 7—PERRY CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
88	9.61	37.09	41.27	12.03	3.70	.86	10982	------------
	Dry	41.03	45.66	13.30	4.10	.95	12150	14331
89	12.45	36.14	42.77	8.64	2.80	.27	11207	------------
	Dry	41.28	48.85	9.87	3.20	.31	12801	14431
90	10.95	37.00	41.82	10.23	3.61	.56	11060	------------
	Dry	41.55	46.96	11.50	4.05	.63	12420	14314
176	10.17	36.37	43.32	10.13	3.43	.48	11180	------------
	Dry	40.48	48.23	11.28	3.61	.52	12446	14254
177	9.45	35.01	41.93	13.61	3.84	.86	10763	------------
	Dry	38.66	46.31	15.03	4.24	.95	11886	14334
182	9.09	36.52	43.91	11.19	3.71	.41	11139	------------
	Dry	39.38	48.30	12.31	4.08	.45	12252	14263
184	7.99	38.16	42.59	11.24	3.57	.52	11290	------------
	Dry	41.48	46.29	12.22	3.88	.56	12271	14263
Average	9.95	36.61	42.51	11.01	3.52	.56	11088	------------
	Dry	40.55	47.22	12.21	3.88	.62	12318	14312

DISTRICT NO. 7—RANDOLPH CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
83	11.13	37.28	40.14	11.45	4.24	.58	10855	------------
	Dry	41.95	45.17	12.89	4.77	.65	12214	14351
229	8.39	37.50	43.61	10.49	3.94	.17	11275	------------
	Dry	40.94	47.60	11.45	4.30	.19	12308	14180
208	10.17	36.48	41.30	12.03	3.78	.61	10940	------------
	Dry	40.61	45.98	13.40	4.24	.67	12184	14388
209	9.64	36.90	41.90	11.54	4.25	.64	10960	------------
	Dry	40.84	46.37	12.77	4.70	.71	12131	14227
210	9.33	36.21	42.96	11.50	3.51	.32	11189	------------
	Dry	39.93	47.38	12.69	3.87	.35	12341	14434
Average	9.73	36.87	41.99	11.40	3.94	.46	11043	------------
	Dry	40.85	46.50	12.64	4.37	.51	12235	14316

DISTRICT NO. 7—SANGAMON CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO₂	B. t. u.	"Unit coal"
74	14.25	38.42	37.22	10.11	4.75	.39	10556	------------
	Dry	44.80	43.42	11.79	5.54	.46	12310	14287
75	14.15	37.58	38.99	9.28	3.76	.45	10786	------------
	Dry	43.77	45.42	10.81	4.38	.52	12564	14369
193	13.12	36.48	40.21	10.18	4.01	.56	10751	------------
	Dry	41.97	46.28	11.72	4.61	.65	12375	14320
B. M. 42	14.82	34.81	39.76	10.60	4.27	------------	10473	------------
	Dry	40.85	46.67	12.47	5.01	------------	12337	14516
Average	14.08	36.82	39.04	10.04	4.19	.46	10641	------------
	Dry	42.84	45.44	11.69	4.88	.54	12396	14373

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts*—Continued.

DISTRICT NO. 7—SHELBY CO., NO. 5 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
217	10.74	36.59	41.48	10.84	3.70	.52	11050	----------
	Dry	41.15	46.64	12.20	4.16	.59	12426	14568

DISTRICT NO. 7—ST. CLAIR CO., NO. 6 COAL

78	11.75	38.71	38.12	11.43	3.63	.80	10874	----------
	Dry	43.86	43.19	12.95	4.11	.91	12322	14466
79	11.31	39.77	38.92	10.00	3.94	.63	11143	----------
	Dry	44.84	43.89	11.27	4.44	.71	12564	14468
80	10.04	39.33	39.09	11.54	3.91	.78	11045	----------
	Dry	43.72	43.45	12.83	4.35	.87	12278	14398
81	11.23	40.36	38.31	10.10	4.03	.54	11126	----------
	Dry	45.47	43.17	11.39	4.54	.61	12533	14444
82	11.94	39.72	37.53	10.81	4.46	.39	10949	----------
	Dry	45.10	42.62	12.27	5.07	.45	12434	14510
200	13.74	31.44	43.54	11.24	1.79	.69	10574	----------
	Dry	36.47	50.49	13.04	2.08	.79	12262	14341
201	11.66	37.78	40.80	10.09	3.69	.39	11087	----------
	Dry	42.38	46.19	11.42	4.18	.44	12550	14537
202	11.09	37.37	39.59	11.93	4.62	.50	10864	----------
	Dry	42.04	44.53	13.42	5.19	.56	12220	14473
203	12.26	39.93	39.32	10.39	4.32	.49	11167	----------
	Dry	44.63	43.86	11.60	4.97	.55	12456	14401
204	11.52	37.20	41.67	9.61	2.82	.10	11155	----------
	Dry	42.05	47.09	10.86	3.19	.10	12607	14394
205	9.67	37.28	41.22	11.82	3.30	.55	11044	----------
	Dry	41.27	45.64	13.08	3.66	.61	12227	14357
B. M.	13.55	34.52	42.06	10.76	3.33	----------	10625	----------
49	Dry	38.90	48.66	12.44	3.86	----------	12320	14419
B. M.	10.75	39.66	37.99	14.00	4.09	----------	10132	----------
50	Dry	41.71	42.55	15.74	4.58	----------	11750	14607
B. M.	10.78	39.18	38.96	11.08	4.11	----------	11069	----------
51	Dry	43.89	43.67	12.43	4.61	----------	12405	14678
Average	11.52	38.01	39.79	11.05	3.71	.53	10918	----------
	Dry	42.59	44.92	12.48	4.20	.60	12352	14463

DISTRICT NO. 7—WASHINGTON CO., NO. 6 COAL

86	11.13	38.20	39.39	11.28	3.91	.50	10964	----------
	Dry	42.98	44.32	12.70	4.40	.56	12337	14448
226	9.42	38.65	39.71	12.21	4.30	.52	10958	----------
	Dry	42.68	43.84	13.47	4.75	.57	12098	14318
Average	10.27	38.42	39.55	11.74	4.10	.51	10961	----------
	Dry	42.83	44.08	13.08	4.57	.56	12217	14383

TABLE 3.—*Average analyses and heat values for separate mines and by counties—grouped according to districts.*—Concluded.

DISTRICT NO. 8—VERMILION CO., NO. 6 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
91	14.44	35.04	40.99	9.53	2.37	.66	10982	------------
	Dry	40.95	47.91	11.14	2.77	.77	12836	14697
92	15.59	33.47	40.16	10.78	2.33	.89	10508	------------
	Dry	39.65	47.58	12.77	2.76	1.06	12449	14536
93	15.19	34.95	41.55	8.31	2.04	.65	10961	------------
	Dry	41.21	48.99	9.80	2.41	.77	12925	14533
95	12.59	40.16	38.53	8.72	3.49	.80	11228	------------
	Dry	45.94	44.08	9.98	3.99	.92	12845	14532
212	14.23	34.00	42.66	9.10	2.30	.77	11043	------------
	Dry	39.60	49.86	10.53	2.66	.90	12873	14616
B. M.	16.16	34.09	39.19	10.56	1.74	----------	10433	------------
53	Dry	40.66	46.75	12.59	2.08	----------	12443	14472
B. M.	15.62	35.59	39.97	8.82	1.68	----------	10845	------------
54	Dry	42.18	47.37	10.45	1.99	----------	12852	14554
Average	14.83	35.72	40.43	9.40	2.27	.75	10857	------------
	Dry	41.45	47.50	11.03	2.66	.88	12946	14562

DISTRICT NO. 8—VERMILION CO., NO. 7 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
94	12.69	38.78	38.89	9.64	3.34	.52	11221	------------
	Dry	44.42	44.54	11.04	3.83	.59	12852	14725
97	13.18	37.85	38.65	10.32	2.54	.60	11080	------------
	Dry	43.59	44.52	11.89	2.92	.69	12762	14754
211	13.63	37.23	39.53	9.60	7.13	----------	11030	------------
	Dry	43.13	45.73	11.13	8.33	----------	12803	14671
Average	13.16	37.95	39.02	9.85	4.33	.56	11110	------------
	Dry	39.02	44.93	11.35	5.02	.64	12805	14716

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

Cooperative Mining Series
BULLETIN 28

PRELIMINARY REPORT ON COAL STRIPPING POSSIBILITIES IN ILLINOIS

BY
HAROLD E. CULVER

ILLINOIS MINING INVESTIGATIONS

Prepared under a cooperative agreement between the Illinois State Geological Survey Division, the Engineering Experiment Station of the University of Illinois and the U. S. Bureau of Mines

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A PRELIMINARY REPORT ON COAL STRIPPING POSSIBILITIES IN ILLINOIS

By Harold E. Culver

INTRODUCTION

General Statement

There has been an increased interest the past year in the stripping method of mining coal in Illinois. The depression in the coal industry in this State, resulting from higher production costs than in some other states, has stimulated operators to turn to this less expensive method of mining. The present compilation of data has been made in response to many requests for information which will aid in the search for strip coal land. This brief and generalized statement of all information now available will serve to show what areas of the State are likely to reward careful prospecting, and at the same time indicate those portions in which there is little likelihood of any commercially important deposits being found. By implication, furthermore, the relative importance of stripping in the coal industry of the State is suggested.

The interest of the public in the quality of coal purchased has emphasized the importance of the relative heating value of strip coal and deep mine coal. For several reasons, chief of which were the extreme shallowness of coal stripped for the market and the lack of care in preparation before present methods were in use, coal obtained by stripping has had a reputation for being wet, dirty, "sooty", high in ash content and low in heating value. With the development of larger stripping machinery and improvements in methods of operation, those features which produced a prejudice against strip coal have been largely removed, and the buying public is finding that coal so obtained is wholly adequate and satisfactory.

Early Coal Stripping in Illinois

As early as 1866, a strip mine was opened on Grape Creek in Vermilion County, and about nine years later another pit was in operation in the Danville bed in the same county. In the meantime, stripping of the Rock Island coal was carried on along Rock River in Henry County. The procedure in all these cases was very simple as no specially designed machinery was used. The surface covering was loosened with a plow and removed with a scraper, and the coal was mined entirely by hand.

A little later, operations were begun in the Mission field in the Danville region. Coal was uncovered by use of a modified dredge, but it was not until about 1890 that any coal was mined and loaded mechanically. Great difficulty was encountered in handling the surface material economically, and modification of the early types of machines appeared in rapid succession. After many failures and moderate successes, the essential features of a successful operation were worked out, and since then the development has been one mainly of dimension. Thinner coal beds and heavier overburden have been successively undertaken, until at the present time coals are being stripped at a profit which a few years ago would have been considered unavailable on any system of mining.

Present Extent of Coal Stripping in Illinois

In spite of the large number of attempts at strip mining that have been recorded in this State, at no time have there been many operations carried on simultaneously. In recent years, the number has somewhat increased, and the latest report of the Department of Mines and Minerals[1] lists a total of eighteen pits.

Table 1 shows that stripping was confined to six counties: Fulton, Jackson, Perry, Saline, Vermilion, and Williamson. The total tonnage so mined, 1,503,541 tons, was only 217,373 tons more than was produced in the same period by a single deep mine in the State. Stripping is as yet a relatively unimportant factor in the coal industry of the State.

The restriction, prior to 1924, of these operations to three coal beds in as many counties is readily understood, when it is remembered that throughout the experimental stage it was necessary that the trials be made where conditions were fairly well known. This was essential not only from the standpoint of operation, but also from that of marketing. With increased stability of the stripping business has come a demand for increased opportunity for stripping, which means the search for and development of new territory, and involves new coal beds as well as extended markets.

Acknowledgments

The preparation of material for this report has been materially aided by the uniformly able and courteous assistance given by the

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[1] Annual coal report of Illinois: Dept. of Mines and Minerals, p. 75, 1924.

operators of strip pits all over the State. In compiling available data, the author has drawn freely upon earlier published work, and has had the benefit of hearty cooperation of his colleagues on the Survey staff whose field work has involved some study of the Pennsylvanian beds. The author gratefully acknowledges the competent work of his assistant, Paul T. Post, in gathering information on the present operations.

TABLE 1.—*Illinois strip mines producing during fiscal year 1293-24*

	Company	County	Production
			Tons
1	*Tiger Coal Mining Company	Fulton	3,525
2	*United Electric Coal Co., No. 9	Fulton	51,950
3	*Buckheart Coal Company	Fulton	5,276
4	*Black Servant Coal Company	Jackson	171,845
5	Scott-Smith Coal Company	Perry	112,100
6	**Gayle Coal Company	Perry	....
7	*Harrisburg Coal Mining Co.	Saline	216,978
8	Yankee Branch Coal Company	Vermilion	38,045
9	Chicago Collieries Company	Vermilion	163,303
10	I. and I. Coal Company	Vermilion	3,800
11	United Electric Coal Co., No. 1	Vermilion	205,487
12	United Electric Coal Co., No. 4	Vermilion	130,297
13	United Electric Coal Co., No. 5	Vermilion	121,896
14	*Coal Belt Coal Company	Williamson	15,366
15	Mammoth Coal Company	Williamson	29,271
16	*Prosperity Coal Co., No. 1	Williamson	3,698
17	*Prosperity Coal Co., No. 2	Williamson	5,704
18	*Quaker Mining Company, No. 1	Williamson	105,000
19	*Quaker Mining Company, Fuel mine	Williamson	120,000
20	**Pyramid Coal Company	Williamson	....
	Total strip coal production	....	1,503,541

* Not producing prior to June 30, 1923.
** Not producing prior to June 30, 1924.

IMPORTANT FEATURES OF STRIP COAL LAND

In estimating the value of a given area for stripping purposes, it is necessary to consider several factors other than the presence of the bed of coal. The more important of these features are noted below, but it should be recognized that none of them can be considered separately, since in actual operations they interact. Thus, exceptionally favorable features of one sort offset unfavorable features of another, and alter the otherwise standard specifications.

Thickness and Quality of the Coal

No absolute figure for a minimum thickness of the coal bed which may be profitably stripped can be given, since the quality of the coal, the impurities in the bed, and the amount of cover, as well as other features are important factors. A commonly accepted minimum is 48 inches for a commercial operation, but other factors may considerably reduce this in certain cases. It should not be assumed, however, that the coal will necessarily be thicker farther under cover than it appears to be at the outcrop. A safe rule is to test thoroughly by drill, auger or test pit, so that the average thickness of the bed will be known. As to quality, no definite limits can be set, other than the demands of the prospective market. The cost of production in a given instance may be so low as to offset the inferior rank of a given coal, and thus make operation commercially practicable. It is best to ascertain the actual quality of the coal by standard methods.

Thickness and Character of Overburden

The mere figure of thickness of overburden is not adequate for accurate estimation of the value of a given tract, but the thickness should nevertheless be carefully measured. For any given field, where quality of coal and market conditions are established, there is usually a fairly definite ratio of thickness of coal to thickness of cover, beyond which it is unsafe to venture. In some areas, this ratio is as low as 1 to 3. Elsewhere, it is considered practicable to attempt 1 to 12. It is clear that the character of the overburden is just as important as the thickness and that the matter is complicated by several factors. Even though soft, unconsolidated material is most easily removed, it frequently happens that coal of better grade is found beneath more resistant strata, the difference in market value of the coal more than offsetting the increased cost of stripping. Again, if the thickness of cover is great, the loose material may slump from the spoil-bank and have to be rehandled at least once, thus greatly increasing the cost.

In early stripping operations, it was considered that the presence of hard beds such as massive sandy shale, black "slate", sandstone, and limestone, precluded the possibility of successful stripping. More recent work has demonstrated that the shale and "slate" do not seriously interfere with operations, and in places, even a 5-foot bed of massive limestone has been handled satisfactorily after shooting. In this connection, it may be noted that the presence of 10 or 12 feet of softer material beneath a hard limestone stratum greatly facilitates its removal, so that 5 feet of limestone at a sufficient interval above the coal is easier to remove than 2 feet of limestone capping the coal bed.

In Illinois, the large and increasing demand for agricultural limestone has led to a consideration of the crushing of the limestone occurring over coal in some strip pits. In most instances, the limestone is entirely suitable for agricultural purposes, and since it must be handled anyway, the operators would do well to consider seriously the utilization of this by-product of coal stripping. At least one pit organization has arranged to market the stone thus obtained.

Percentage Recovered by Stripping

Given the size of the tract from which cover can be removed profitably and the thickness of the bed of coal, the calculation of the actual amount of coal in the tract can easily be made, as an acre-foot of coal in the ground weighs about 1,770 tons. This figure does not, however, give the amount of coal that will be produced in the stripping for there are many factors to interfere with complete recovery. A loss of only five per cent is obtainable under exceptionally favorable conditions, but 90 per cent recovery is a safer factor for the calculation of reserves.

Transportation and Market

For a stripping operation of any size, the market situation must be fairly well canvassed with respect to a reasonably continuous demand for coal of the rank which can be produced. The matter of transportation also becomes of added importance. For small operations, the market situation can be estimated readily, since the production will be disposed of to domestic consumers. Transportation in such instances is largely outside the problem, as most of the coal is sold at the tipple.

For moderate operations, team or truck service must be planned, with highways suited to such heavy traffic in any weather. For larger operations, proximity to an established public carrier is important. A given tract might be commercially valuable if close to a freight line, and be useless ten miles away because of the increase in cost of production resulting from the demand for greater power, larger equipment, and more labor.

POSSIBLE STRIP COAL AREAS IN ILLINOIS

General Statement

Because so large a part of the enormous coal reserves of the State are readily accessible to underground mining, it might be expected that

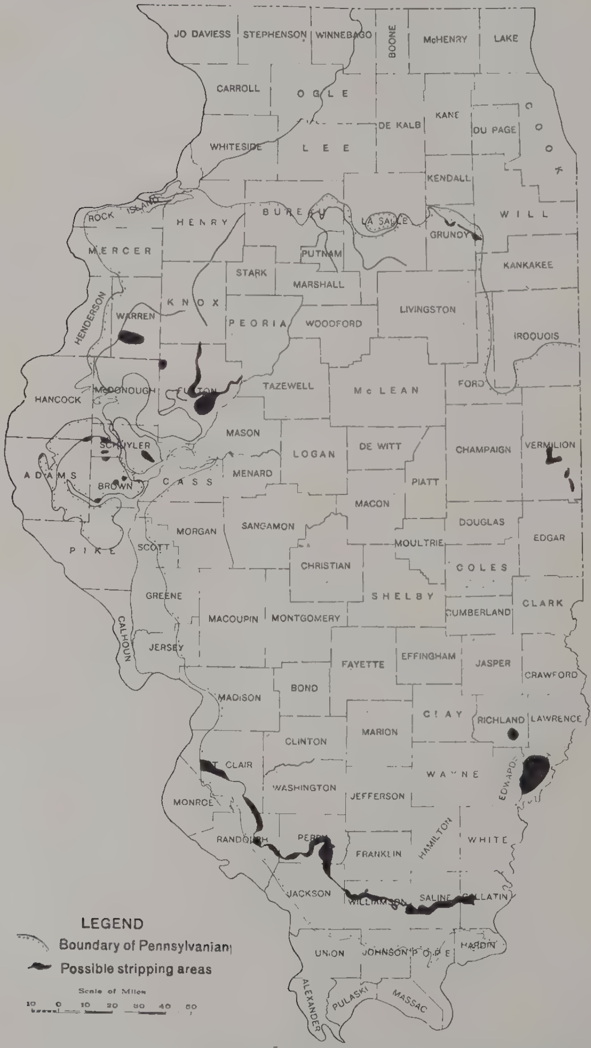

FIG. 1. Map of Illinois showing locations of possible stripping areas. The solid lines within the boundary of the Pennsylvanian system represent the line of outcrop of the several coal beds.

strip mining would be practicable in most of the counties which are underlain by workable coal beds. On the contrary, only a small fraction of the total coal area is open to stripping, and this part does not contain its proportionate fraction of the total reserves, because of the concentration of the larger reserves in the deeper parts of the field.

Geology of the Illinois Coal Field

GENERAL STRUCTURE OF THE PENNSYLVANIAN SYSTEM

The great mass of rocks comprising the Pennsylvanian system fills a very broad and shallow depression south of the latitude of Rock Island, Rock Island County (fig. 1). Although the upper surface of the Pennsylvanian rocks is nearly flat, the lower surface slopes from the margin toward the deepest part of the basin. This gives a plano-convex lens shape to the system as a whole, with the greatest thickness of the beds where the basin is deepest. This deepest part is not situated in the center of the field, but is well to the southeast in Wayne County, making the basin unsymmetrical. Folding may have altered the angle of slope in some places, but in general, the beds show the low inclination acquired during the period of deposition and later consolidation. The ultimate effect has been to produce belts parallel to the margin of the field in which the gently inclined beds of coal are so lightly covered as to be available for stripping. The outer limit of these belts is indicated by the line of outcrop of the several coal beds (fig. 1). The width of the belts is obviously dependent upon the angle of slope of the strata, wider where the angle is low and narrower where it is high.

VERTICAL RANGE OF THE COAL BEDS

Neither the uppermost nor the lowermost portions of the Pennsylvanian in this State include the commercially important beds of coal. The thicker and more extensive beds are restricted to a 500-foot section approximately in the middle of the Pennsylvanian system. For this reason, the width of the marginal belts mentioned above is greatly restricted, and on the outer side of the belts, as well as on the side toward the interior of the basin, there are extensive areas in which stripping will not be important because of the absence of suitable coal beds. As the most favorable site for stripping is along the outer edge of beds now worked by underground methods, the introduction of open pit mining does not necessarily involve the utilization of any beds not now exploited. It will, however, serve to increase the total production of coal from these beds by extraction from the portions which are too shallow for deep mining. The inner limit of the stripping belt practically coincides with the outer limit of deep mining. In a general way, the areas available for strip mining will be found in a zone marginal to the present producing fields.

COAL BEDS ABOVE OR BELOW THE MIDDLE SECTION

In addition to the main producing districts of the State, there are numerous small areas which are known to be underlain by thin coal at shallow depths. Although most of these areas are small, the total acreage involved is appreciable. Occurrences of such beds in the lower part of the Pennsylvanian system are known, for example, in Saline County, south of the line of outcrop of the Harrisburg coal, the main producing bed of the district. In the upper part of the Pennsylvanian also are several thin coals, which in general are found in the interior of the field, as in Effingham and Crawford counties.

Where known to lie at shallow depths, these beds are mainly too thin to be valuable, so that no great importance may be attached to them on the basis of present data. As most coal testing has been confined to the immediate vicinity of the producing mines, it appears probable that an equal amount of drilling in these areas of shallow thin coal will reveal the presence of thicker portions not now known.

EROSION ALONG STREAM VALLEYS

Many Illinois streams flow through wide bottom valleys, somewhat below the general level of the surrounding region. Where such drainage lines cross areas underlain by workable coals, the overburden has been removed to a greater or less extent. The maximum depth of excavation is more than 100 feet in places, but along most streams it is less. The removal of even 20 feet might bring a deeply buried coal bed within the range of stripping operations. Such conditions are known in the vicinity of many drift and slope mines in which part of the workings have been abandoned on account of poor roof beneath drainage lines.

Much of the early stripping in Illinois was done in areas of this type, as in northern Henry County, where erosion by Rock River has reduced the very thick cover to less than 10 feet, so that the Rock Island coal could be stripped cheaply by team and hand scraper. In the Carterville field of Williamson County, and particularly in the Danville field of Vermilion County, operators have been quick to take advantage of the partial elimination of overburden in stream valleys. In places the operations have been continued to an extent that demanded a shifting of positions of stream channels. No careful estimate has been made of the acreage which has been added in this way to the areas available for stripping. However important in the location of a single strip pit, it is clear that this factor is of minor importance in affecting the production of the field as a whole.

AREAS OF POCKET COAL

Outside the margin of the extensive swamp areas which were the site of deposition of the more widespread coal beds of the Illinois basin, there appear to have been many similar but smaller depressions in which coal-forming matter accumulated. This marginal deposition gave rise to scores of disconnected pockets of coal of variable thickness and shape. Because of the conditions under which they were laid down, these beds do not show uniform composition but are as variable in their content of impurities as in their shape. The present western edge of the Illinois field coincides roughly with this old marginal zone, and hence this region is characterized by coals that are irregular both in extent and composition. It is to be expected, therefore, that in much of the large area in which coal is known to be present at shallow depth, it will be found to be too thin or too impure to be commercially valuable.

This situation is especially well illustrated in that part of the coal basin lying west of the Illinois, but it may also be found to obtain in other parts of the State as well. On this account the available stripping area may be reduced by an unknown but appreciable amount.

GLACIAL DRIFT

The deposits of sand, gravel, and boulder clay which mantle practically all of the coal field, add greatly to the complexity of the problems of open pit mining. Perhaps the most important effect is in the addition to the amount of overburden, making unavailable some coal that otherwise could be stripped. This is especially true throughout the northern part of the field where the thickness of the surficial material is excessive, in some places reaching a maximum of 200 feet. A second effect is the concealment of bed rock relations, necessitating extensive drilling to ascertain the presence or absence of the coal, the total overburden and the amount of included bed rock.

In addition, although the drift materials are commonly unconsolidated, and hence easily removed, their occurrence in excessive thicknesses makes them difficult to handle in wet weather because of the tendency to slump from the spoilbank into the open cut.

Estimation of Available Area and Tonnage

In a consideration of the areas which are here suggested as possible strip coal lands, it should be remembered that the data on which the suggestions are based are very incomplete. No special field work has been done on which an estimate of the availability of coal land for stripping could be based, and it has therefore been necessary to make use of data gathered largely as an incidental phase of other studies. These include topographic maps, records of outcrops, well logs, mine workings, and similar material, from which both thickness of any given coal and its depth below the surface may be calculated.

On figure 1 are indicated approximately the stripping areas in the State, to show the relation of the fields to each other, and to the rest of the State. Accompanying the detailed discussion of each county is presented a larger scale map showing the position of possible strip lands in greater detail. It is clear that areas mapped as possible strip lands are those which available data indicate as worthy of test. It is to be expected that some portions of these areas will be found to contain coal or overburden of such thickness as to make commercial operations impracticable. Additional areas not now known will presumably be found as the search for strip land progresses. The boundaries of areas indicated are necessarily generalized and subject to revision as more accurate data become available. Similarly, the thickness of coal and the amount of overburden are calculated from present information, and are subject to corrections for the areas less well known. Because of these features, the estimation of tonnage available by stripping as presented in Table 2 is necessarily an approximation. The figures are included only in order to give some idea of the amount of coal for any given field. It should be noted that this calculation is based on a recovery of 100 per cent of the coal, as the variations from this figure due to local geologic conditions or methods of mining can not well be calculated in advance of actual operations.

The total available tonnage of strip coal in Illinois has been estimated to be 1,407 million tons from an area of 287 square miles. It has also been estimated that 197 square miles are underlain by strip coal 48 or more inches thick and can supply 1,137 million tons of strip coal. Of the original coal resources in Illinois—137,000 million tons, 1.02 per cent represents the estimated stripping resources.

CHEMICAL COMPOSITION OF STRIP COAL

As noted earlier in this report, strip coal has long had a reputation for its high content of impurities. It is obvious that coal exposed to weathering agencies deteriorates both in composition and appearance. The more readily volatilized constituents are lost to the air, or oxidized through the action of percolating water; the pyrite which always is present in coal beds is decomposed and the resulting iron oxide is scattered through the bed as a rusty stain which detracts materially from the appearance of the coal and which can not be removed as the unweathered pyrite could.

Coal overlain by a thin mantle of glacial drift is likely to have the character of weathered coal. The earlier stripping done in this State was of coal in just this situation, so that the marketed product was necessarily of lower grade than that from the more deeply buried portions of the bed.

TABLE 2.—*Estimate of stripping resources in Illinois*

County	Thickness	Area	Tonnage
	Inches	*Sq. mi.*	*Millions of tons*
Adams	30	2	5
Brown	24	3	6
Fulton, Springfield (No. 5) bed	48	60	272
Fulton, Colchester (No. 2) bed	30	5	14
Gallatin	72	3	20
Grundy (including Will)	30	9	25
Hancock	30	5	14
Jackson	72	8	54
Knox		(No estimate)	
Perry	72	35	238
Randolph	72	19	129
Richland	24	4	9
Saline, Herrin (No. 6) bed	36	2	6
Saline, Harrisburg (No. 5) bed	60	6	34
Schuyler	66	12	74
St. Clair	60	30	170
Vermilion, Danville (No. 7) bed	54	10	51
Vermilion, Grape Creek (No. 6) bed	72	4	27
Wabash	36	40	135
Warren	30	20	56
Williamson	72	10	68
Total		287	1407

Again, both upper and lower surfaces of the bed of coal are likely to be uneven. Unless the stripping and loading of such a bed be done with extreme care, a considerable admixture of shale, bone coal, and floor clay will probably result. Early stripping, done with inadequate equipment, resulted in the loading of much incombustible material with the coal.

TABLE 3.—*Comparative analyses of strip and deep mine coal from the same bed*[a]

As received						Dry					
Moisture	Vol. mat.	Fixed carbon	Ash	Sulphur	B. t. u.	Vol. mat.	Fixed carbon	Ash	Sulphur	B. t. u	No. of analyses
13.79	*37.62*	*39.28*	*9.31*	*3.50*	*10956*	*43.64*	*45.56*	*10.80*	*4.06*	*12708*	*Single*
14.89	35.48	40.75	8.88	3.78	10969	41.68	47.88	10.44	4.43	12887	Single
13.89	*34.87*	*36.54*	*14.70*	*5.80*	*10036*	*40.50*	*42.43*	*17.07*	*6.73*	*11656*	*Single*
16.83	34.68	39.79	8.70	3.94	10628	41.71	47.83	10.46	4.74	12778	Single
13.75	*36.59*	*37.38*	*12.28*	*2.92*	*10560*	*42.42*	*43.34*	*14.24*	*3.38*	*12243*	*Single*
14.04	36.14	39.28	10.54	3.46	10721	42.04	45.69	12.27	4.02	12472	Single
12.36	*36.69*	*40.90*	*10.05*	*3.00*	*11194*	*41.87*	*46.67*	*11.46*	*3.42*	*12733*	*Single*
12.03	36.30	39.67	12.00	3.35	10779	41.27	45.08	13.65	3.81	12254	Single
11.52	*37.20*	*41.67*	*9.61*	*2.82*	*11155*	*42.05*	*47.09*	*10.86*	*3.19*	*12607*	*Single*
11.09	37.37	39.59	11.93	4.62	10864	42.04	44.53	13.42	5.19	12220	Average of 3
6.40	*36.71*	*47.70*	*9.19*	*3.41*	*12150*	*39.22*	*50.96*	*9.82*	*3.64*	*12981*	*Single*
7.29	34.93	47.65	10.13	3.78	11745	37.68	51.39	10.93	4.08	12669	Single
6.40	*36.38*	*48.20*	*9.02*	*3.45*	*12179*	*38.87*	*51.49*	*9.64*	*3.69*	*13012*	*Single*
6.95	36.05	45.33	11.65	3.54	11744	38.75	48.73	12.51	3.81	12623	Average of 3
13.10	*37.70*	*39.80*	*9.40*	*2.80*	*11110*	*43.40*	*45.80*	*10.80*	*3.20*	*12770*	*Single*
12.20	39.53	38.38	9.89	3.76	11243	45.03	43.70	11.27	4.29	12804	Single
14.10	*37.00*	*39.30*	*9.60*	*2.90*	*11030*	*43.10*	*45.70*	*11.20*	*3.40*	*12480*	*Single*
12.76	38.84	38.31	10.09	3.91	11106	44.53	43.91	11.56	4.48	12788	Single
13.70	*37.00*	*39.50*	*9.80*	*3.20*	*11050*	*42.90*	*45.70*	*11.40*	*3.70*	*12800*	*Single*
13.53	37.39	39.57	9.51	3.20	11045	43.24	45.76	11.00	3.70	12773	Single
13.63	*37.23*	*39.53*	*9.60*	*2.96*	*11030*	*43.13*	*45.73*	*11.13*	*3.36*	*12803*	*Average of 3*
12.69	38.78	38.89	9.64	3.34	11221	44.42	44.54	11.04	3.83	12852	Average of 6

[a] Figures in italics refer to strip coal.

A thicker cover of drift means greater protection from weathering, resulting in a higher grade of coal. A hard, relatively impermeable boulder clay is obviously a better cover than one of sand and gravel of even greater thickness. Where the overburden includes bed rock, weathering is still further prevented. A stratum of well bedded shale beneath a limestone of moderate thickness makes an especially good cover, as the limestone stratum diverts much of the ground water and the shale transmits but little of the rest of the moisture to the coal.

The large size of present equipment for stripping permits the removal of a much thicker overburden than was formerly possible, and the great strength of the machines now in use allows the handling of the more resistant bed rock. Coal of excellent quality is therefore uncovered in modern pits. With greater care in cleaning the surface of the strip bed, and better control of loading shovels than was formerly possible, the loaded coal may be as clean as that from deep mines. Impurities that are present in all coal beds, such as lenses or balls of pyrite and bands of shale or bone may be as completely eliminated on the picking tables of a strip mine as those of a deep mine. From the geologic point of view, therefore, strip coal is not inherently of poorer quality than deep mine coal.

The analyses in Table 3 which represent face samples of coal, show the composition of coal from strip mines and from deep mines working the same bed. In order to conceal the identity of analyses, it has been necessary to omit the designation of the bed or of the county in which it was sampled. Each pair of analyses, however, is of the same bed, the deep mine sample being chosen from a location as near as possible to that taken from the strip mine. It must be remembered that the samples are of face coal, and hence not exactly indicative of commercial output. Depending on methods and care in mining, the loaded coal will be better or poorer in grade than the face sample. Even casual inspection of the analyses will show that the coal at the face of a strip pit is fairly comparable with that at the face in a deep mine.

COUNTY REPORTS

ADAMS COUNTY

The Adams County coal beds belong to that part of the Illinois field which has been cut off from the main basin by Crooked Creek and Illinois River (fig. 1). The whole series is relatively thin in this area, and the included coals are of comparatively little value.

A small area surrounding the southeast corner of T. 2 N., R. 8 W. lying northeast of the village of Mendon (fig. 2), is known to contain coal which might be stripped. Elsewhere in this county conditions appear to be unfavorable for commercial stripping, although there are small patches where thin coal is so lightly covered that small scale stripping may be possible.

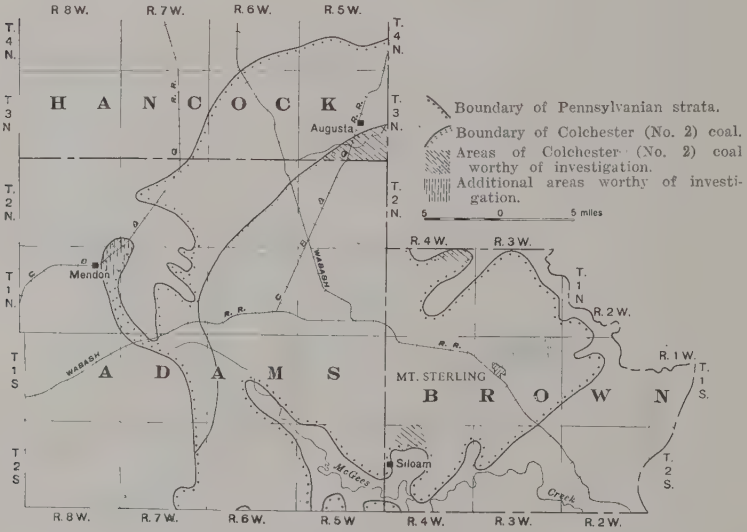

FIG. 2. Index map of Adams, Brown and Hancock counties.

The coal northeast of Mendon has an average thickness of 48 inches, but it is nearly 60 inches at its maximum. The bed is distinctly limited in extent, however, and shows the high content of impurities common to marginal deposits. A measured section shows a 2-inch bone band 8 inches from the top of the bed, and a 2-inch band of shale 28 inches above the sandstone floor.

The original shale roof material has been replaced locally by glacial drift. Over the small area observable, the cover ranges from 2 to 30 feet, and probably contains little bed rock. In sec. 36, T. 2 N., R. 8 W., a small stripping operation was producing coal in 1922, but no later reports are available.

Brown County

The major portion of the large area of Brown County north and east of McGees Creek is probably underlain by the Colchester or No. 2 coal. Most of this region is so heavily covered however, that it is doubtful if any commercial strip land is included. In two places, one northwest of Mt. Sterling, in T. 1 N., R. 1 W., and the other north of Siloam in T. 2 S., R. 4 W. (fig. 2) local stripping has been attempted, and these points are noted on the map as worthy of investigation.

The coal in either place is about 2 feet in thickness, varying but little over wide areas, and having some impurities but no regular partings. The covering is less than 20 feet thick locally, but it is not known over how large an area such relations obtain. Where thin, the cover is largely glacial drift and the coal relatively soft and weathered. The thicker cover includes varying amounts of bed rock which is mainly sandstone and shale, but which in places includes a massive limestone. In the character of cover, this field resembles Schuyler County to the north.

Over a small area just north of Mt. Sterling, a coal stratigraphically above the Colchester (No. 2), locally called No. 5, has been mined in the past. It is near the surface, the cover along the creeks being thin but including a considerable thickness of bed rock, in part limestone. In outcrops, this coal is less than 2 feet thick and bony, and is not listed among the probable coal resources of the county.

Clay County

Described on page 57.

Edwards County

Described on page 57.

Effingham County

Described on page 57.

Fulton County

Fulton County has long been recognized as containing within its boundaries some very desirable stripping areas, but it is only within the last few years that development on a commercial scale has been attempted. The large scale operations in the vicinity of Cuba will probably be followed by others. The Cuba coal appears to be present throughout a considerable area under approximately the same conditions of cover, thickness of coal and relation to drainage. Part or all of each of the following townships seem to merit some exploratory work:

T. 5 N., Rs. 3 and 4 E.	T. 7 N., R. 3 E.
T. 6 N., Rs. 2, 3, 4, and 5 E.	T. 8 N., R. 3 E.

The coal is the Springfield (No. 5) bed, which has long been worked underground in this county, and even more extensively in the counties east and south. The character and general relations of the coal are already well known,[1, 2] leaving only the matter of thickness of bed and thickness and character of overburden to be determined in exploratory work.

The thickness of the coal is remarkably uniform, ranging from 48 to 60 inches wherever measured. The characteristic feature of this bed, namely, the presence of clay-slips or "horsebacks" is of importance in any projected operation. The slips range from a few inches to several feet in width, and are very irregular in distribution, some areas being quite free from them, others, having as many as twelve slips in a distance of 15 feet.

The overburden is extremely variable both in thickness and in character. Throughout the areas indicated in figure 3, the cover is believed to be less than 65 feet, which may be the limit of practicable operation for the thickness of coal uncovered. The size of tracts in which the cover is of uniform thickness depends more on the surface configuration than on any other factor. Where undisturbed by erosion, the common sequence of strata over the No. 5 coal is 2 feet of black laminated shale composing the roof, overlain by limestone less than 1 foot thick, over which lies shale up to 25 feet in thickness with a variable amount of till over the whole. This group of beds is common in the eastern part of the county, but is not uniformly present over the coal farther to the west and south where the interval between the No. 5 and No. 6 coals is locally as small as 8 feet. At points where the interval is small, the shale is commonly replaced by sandstone. In places, the sandstone cuts out the limestone cap of the No. 5 coal. In this connection, it is of importance to note that where the sandstone is of appreciable thickness, the coal bed is essentially free from clay-slips. In such areas the prospective operator of a strip pit

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[1] Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Ill. State Geol. Survey Bull. 43, p. 209, 1922.

[2] Cady, G. H., Coal resources of District IV: Ill. Min. Inv. Bull. 26, 1921.

must consider the removal of at least 25 feet of hard sandstone, in order to reach a coal that will show few interruptions of the "horseback" type.

The Springfield coal has been stripped in a small way for many years in places where the cover is unusually thin. Within the past three years, however, extensive drilling in the Cuba area has shown the feasibility of pits on commercial scale, and two such pits are being operated in secs. 28 and 29, T. 6 N., R. 3 E. at the present time. One other pit in T. 6 N., R. 4 E. has been reported.

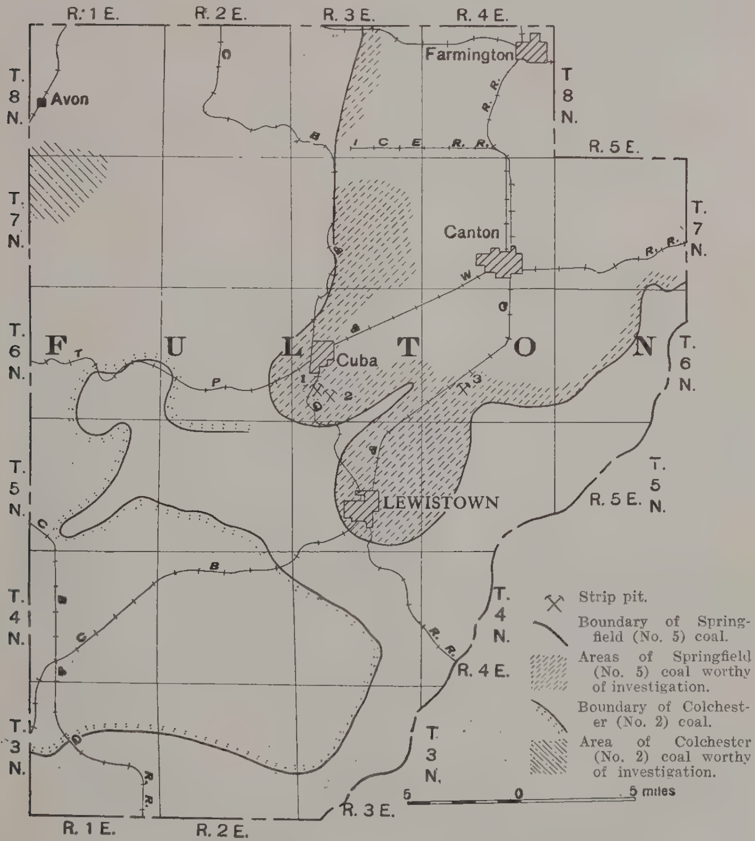

R. 1 E.
R. 2 E.
R. 3 E.
R. 4 E.
R. 5 E.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
Avon
Farmington
Canton
Cuba
LEWISTOWN
F U L T O N
I. C. E. R. R.
1
2
3
5 0 5 miles
✕ Strip pit.
Boundary of Springfield (No. 5) coal.
Areas of Springfield (No. 5) coal worthy of investigation.
Boundary of Colchester (No. 2) coal.
Area of Colchester (No. 2) coal worthy of investigation.

FIG. 3. Index map of Fulton County. Figures accompanying strip pit symbols refer to mines listed in Table 1.

At the time of visit by a Survey representative, the following section of coal and overburden was exposed at the pit in sec. 28, T. 6 N., R. 3 E.:

Section exposed at pit in sec. 28, T. 6 N., R. 3 E.

	Thickness	
	Ft.	*In.*
Soil and till, with boulders up to 18 inches in diameter; becomes plastic when wet	26	..
Shale, light gray, not well bedded	..	4
Limestone, medium gray, argillaceous, fossiliferous (locally nearly 2 feet thick)	..	8
Shale, very tough, dark, slaty at base	2	9
Coal	4	9
Underclay, light gray, without grit	..	..

The stripping is done by three electric shovels, two with 90-foot booms carrying 6-yard dippers and one with an 80-foot boom carrying an 8-yard dipper. The pit equipment is well shown in figure 4. In operating, the stripping shovel makes a straight cut, the loading tracks being shifted as the stripping shovel returns. The surficial material not removed by the stripping shovel is handled by a shovel gang followed by sweepers. The coal is shot with blasting powder, preparatory to being loaded out by the electric shovels having a dipper capacity of one and three-fourths yards. Haulage from the pit is accomplished by use of locomotives pulling trips of twelve 6-ton cars. A rotary 2-car dump operated by compressed air turns the loads on to a steel conveyor which takes the coal to the tipple for cleaning and sizing. Four loading booms handle the coal from tipple to railway cars.

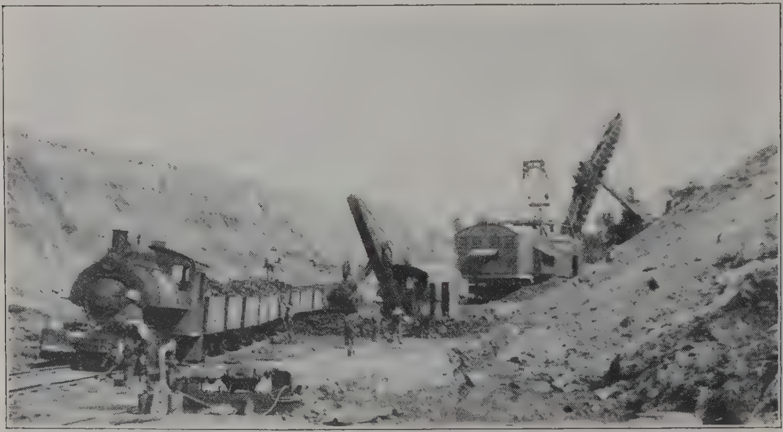


FIG. 4. Stripping operation in the Cuba field.

In addition to the areas above noted in which the Springfield (No. 5) coal lies at shallow depth, there probably are small fields in the western part of the county in which the Colchester (No. 2) coal is near enough to the surface to be stripped. One of these tracts is in the northwest quarter of T. 7 N., R. 1 E., south of Avon (fig. 3.)

In this field, the Colchester coal has an average thickness of 30 inches, varying but little from that amount over considerable areas. This bed is regularly without partings, and contains only a small amount of impurities. Its thinness obviously prevents its being considered where the overburden averages more than 30 feet in thickness, and it is probably of only local interest as a stripping coal.

The overburden is largely shale, which in places includes some thin black "slate" and nodular limestone. It seems probable that in part or all of secs. 3, 4, 5, 6, 7, 8, 17 and 18, T. 7 N., R. 1 E., the overburden does not exceed 60 feet, and that limited tracts of lesser cover will be found. Extensive drilling will be necessary to prove the presence of the coal in parts of this tract.

A similar area, somewhat larger, has been reported is Tps. 3 and 4 N., R. 1 E., but recent geologic work in this field indicates that the Colchester coal is here too deeply buried to be available for shovels.

Gallatin County

So little is known of the coal geology of Gallatin County that it is not possible to define the stripping areas adequately. As noted in the discussion of strip land in Saline County (p. 40), there is an extension of the geologic conditions found in eastern Saline into western Gallatin (fig. 20). The outcrop lines of both the Harrisburg (No. 5) and Herrin (No. 6) coals pass through T. 9 S., R. 8 E., but their trend beneath the lowland to the east and north is not known.

In this area the Herrin coal is from 36 to 68 inches thick, as shown in drill records, and exhibits the usual parting of shale near the bottom of the bed. For detailed description of this coal, the reader is referred to the report on Williamson County.

The overburden is heavy, except just at the outcrop, so that only a narrow belt can be included in the stripping field. Immediately over the coal is thin black shale, locally slaty, and over this a limestone cap rock which may be as much as 5 feet thick and which is in places separated from the black shale by several feet of gray shale.

The Harrisburg coal in Gallatin County has essentially the same character as noted in the Saline County report. Partings of pyrite may be slightly more common in this field, and the coal on the whole less thick.

The chief difference in the overburden above the Harrisburg coal in Saline and Gallatin counties is in the absence of the limestone in the latter. This leaves only the gray and black shale with an overlying sandstone in places in the bed rock portions of the overburden. Surficial clays, here as elsewhere, cover the bed rock.

In the area tentatively mapped as worth testing for stripping possibilities, the total overburden is thought to be under 60 feet. It is probable that along stream lines, erosion has reduced this to a smaller figure and that fair sized tracts will be found to be available for stripping the Harrisburg coal.

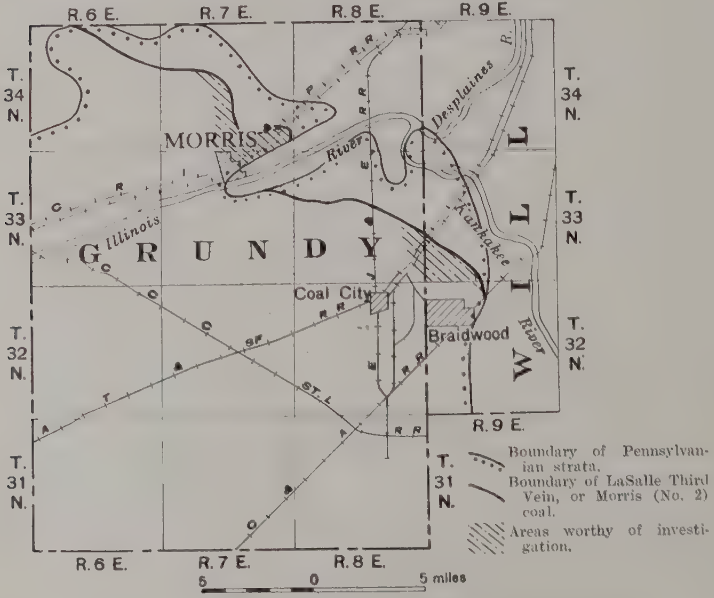


Fig. 5. Index map of Grundy and southwestern Will counties.

Grundy and Will Counties

Although more than the southern half of Grundy County is underlain by workable coal, it is only along the north margin of the field that the cover is so slight that stripping appears practicable (fig. 5). In the south central part of T. 31 N., R. 7 E., available records show 2 to 3 feet of coal at less than 60 feet below the surface. Early mining in this area has probably rendered at least half of this coal unminable, and records do not show precisely what parts have been mined out. It appears probable that west of the area mapped for investigation north of Morris, the coal is too deeply buried for stripping. Even along the boundary of the coal to the northwest, the heavier morainic covering prevents stripping. On the south side of the Kankakee in T. 33 N., Rs. 8 and 9 E., there is another tract of about 2½ square miles mostly in Grundy County, but extending across the line into western Will County in which similar conditions obtain.

In both areas, the available coal is the La Salle Third Vein or Morris coal, correlated as No. 2 of the Illinois series. This ranges from 30 to 42 inches in thickness, and is exceptionally uniform for considerable distances. The thin cover over the coal in the south tract has resulted from erosion by glacial waters passing down Kankakee Valley. Because of this fact, it is to be expected that locally the coal, as well as the heavier overburden, has been removed, a feature which should be given consideration in future prospecting. The coal is of good quality, generally free from bedded impurities and without prominent interruptions, with the possible exception above noted.

The overburden, as shown by logs, consists of the roof shale, a somewhat massive gray, slightly sandy bed, and the usual boulder till. The latter has been removed over much of the area north of Coal City and Braidwood and replaced by unconsolidated silts and sands of the glacial streams. In places, heavy gravels may be encountered. The cover is probably less than 50 feet thick in general, and some fairly large tracts will probably be found in which the cover is less than 30 feet.

HANCOCK COUNTY

Although patches of Pennsylvanian beds are found in many parts of Hancock County, the only area in which stripping possibilities appear to warrant testing lies south of Augusta in T. 3 N., R. 5 W. (fig. 2, p. 20).

In this area the Colchester (No. 2) coal, with an average thickness of 30 inches, has been worked both north and south of William Creek. The bed has no persistent parting, although the upper part is commonly harder and brighter than the lower. Over part of the field, a slightly thinner coal, known as "the cannel", underlies the Colchester at a distance varying from 2 to 8 feet. It is probable that any stripping operation opened in the Colchester coal could in places be profitably carried down to the next lower coal.

The overburden ranges from less than 10 feet to 100 feet or more in thickness. The uneven surface of the coal itself results in a cover of uneven thickness, which prevents accurate estimation of thickness in advance of testing. Where thin, the overburden is largely glacial drift, but where it is more than 15 feet, it normally includes some bed rock. Shale and sandstone in considerable thickness are reported in drill logs, and a 9-foot limestone appears in some records. On account of the thinness of the coal, it is probable that not more than 25 feet of cover could be handled profitably.

No stripping has as yet been reported from the Augusta field, although the coal has been worked from several openings, both shaft and drift.

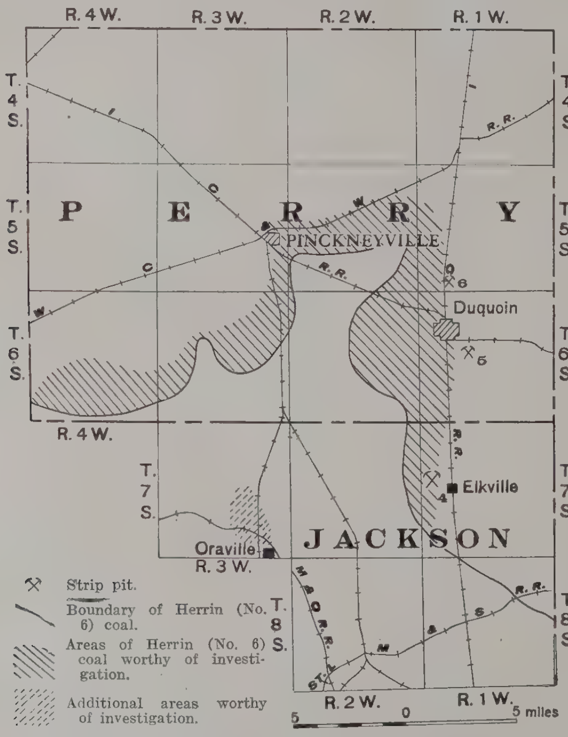


FIG. 6. Index map of Perry and Jackson counties. Figures accompanying strip pit symbols refer to mines listed in Table 1.

Near Nauvoo at the western edge of the county, a thin coal was stripped by the Mormons at an early date, but this bed appears to be of so little value that it is not included in the present estimate of stripping resources.

JACKSON COUNTY

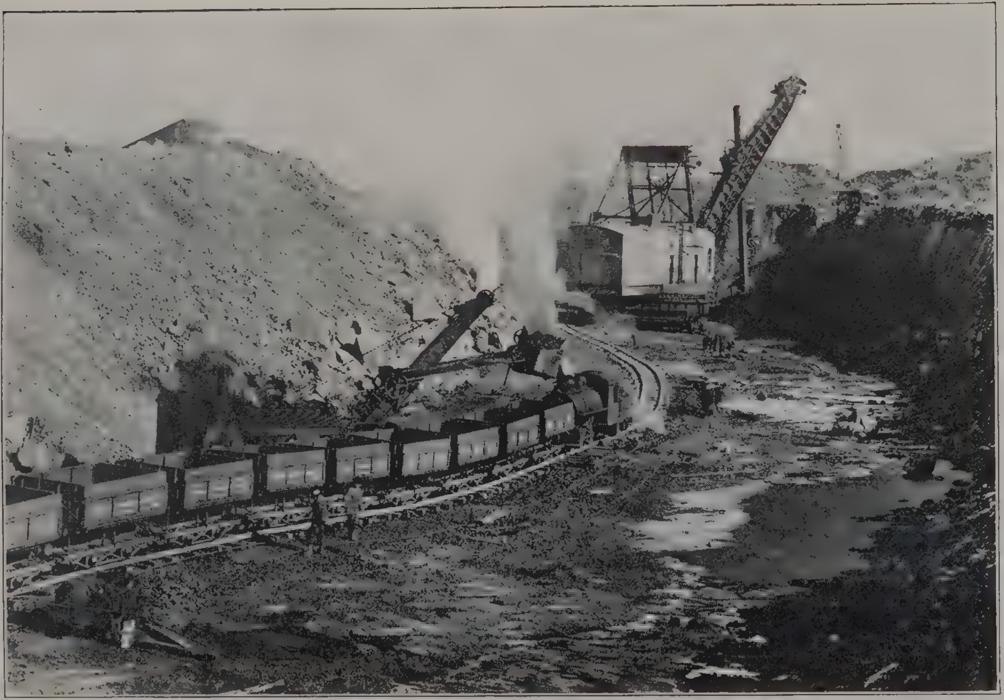
The only field in Jackson County in which stripping is known to be a possibility, is in the vicinity of Elkville in T. 7 S., Rs. 1 and 2 W. (fig. 6). Beds in this field constitute an extension of the strip lands of southeastern Perry County. A heavy cover of glacial drift prevents determination of the position of the outcrop, and hence the exact area of strip land can not be described. Because of the eastern dip of the coal on the east side of the Duquoin fold, the stripping area is limited in that direction. To the north and west, and possibly to the south, even beyond the mapped boundary for the coal, are lands well worth testing for shallow coal.

The coal in this field is the Herrin (No. 6) bed, which has been mined by underground methods throughout the area to the north and east. In this region it appears to maintain a thickness of about 84 inches, but this may be reduced nearer the outcrop. As elsewhere in southern Illinois, this bed carries the "blue band", a persistent shale parting, below the middle of the bed. Other partings of shale or pyrite are noted locally, but none are as widespread as the "blue band".

The coal is immediately overlain by shale, locally black and slaty, elsewhere gray and more massive. Above this appears the usual cap limestone, in places more than 5 feet thick, but not uniformly present. This in turn is overlain by more shale and glacial materials of varying thickness. Figure 7 shows the character of the overburden, the steep walls of uncut surficial material are seen at the right, the spoil bank showing the blocks of underlying limestone at the left. In places the coal apparently has an overburden less than 25 feet thick, but some records indicate a thickness of more than 60 feet. The prospector must consider the probability that the surface of the coal is uneven, so that, although the land surface is flat over the area indicated on the map, the variation in thickness of cover due to that feature alone may be more than 10 feet.

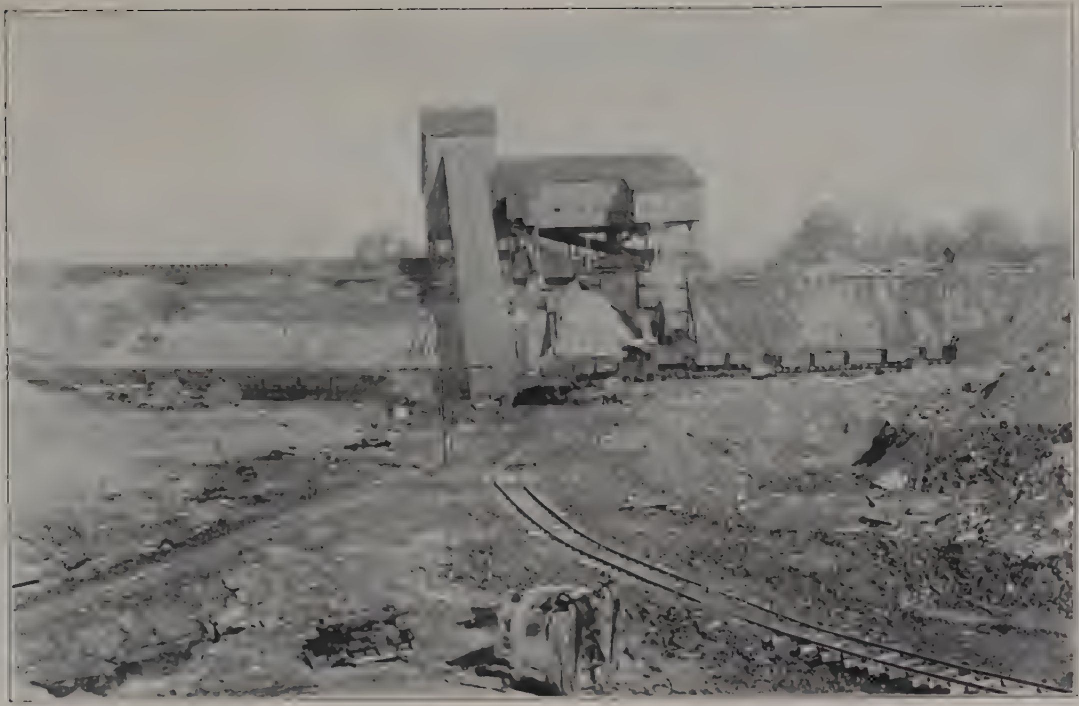
Up to the last few years, commercial stripping had not been attempted in this field, on account of the cap limestone which had been considered an insurmountable difficulty. In the pit which is now operating about a mile and a half west of Elkville, this difficulty seems to have been satisfactorily overcome, by use of extra large and sturdy equipment. Here, the stripping shovels are two in number, both electrically operated and handling 8-yard dippers. The coal is hauled from the pit over a 36-inch gage track by steam locomotives, dumped through a hopper (fig. 8) to an endless conveyor which carries it to the shaker screens where standard Illinois sizes are prepared. Picking tipples and loading booms are installed to permit the loading of clean and properly sized coal. The tipple is planned for a capacity of over 2500 tons per day.

In the southeastern part of T. 7 S., R. 3 W. near Oraville is a



Courtesy of Black Servant Coal Company.

FIG. 7. Strip pit at Elkville, T. 7 S., R. 1 W., Jackson County.



Courtesy of Black Servant Coal Company.

FIG. 8. Tipple and layout at Elkville pit, T. 7 S., R. 1 W., Jackson County.

tract of small size that may repay investigation for stripping. The coal in this field appears to lie too low to be at the horizon of the Herrin (No. 6) bed, and too high for that of the Murphysboro (No. 2) bed. It may be a local development of the No. 5 coal, such as occurs south of the Sparta field in Randolph County. The coal has been mined by drift and shallow shafts for many years, but it is possible that testing will show some valuable tracts. The bed ranges from 72 to 90 inches in thickness, and appears to be of excellent quality, although no analyses of standard type are available. Little is known of the character of the overburden, but it appears to include some sandstone, although it may be mainly shale. The known thickness of cover is less than 60 feet in places, but since so little is known of the lay of the bed, it is impossible to gage the size or value of the tract. This bed is not included in the estimate for the county.

Jefferson County

Described on page 57.

Johnson County

Described on page 58.

Knox County

In spite of the fact that four different seams of coal have been worked by underground methods in Knox County, it is not evident from available data that there are any considerable areas of strip coal within its limits. Two regions might be mentioned as being perhaps worthy of some exploratory work (fig. 9).

The first of these lies along the outcrop of the Herrin (No. 6) coal, in the vicinity of Oneida and Wataga. The overburden may be light enough, especially along drainage lines, to permit shovel work in uncovering the coal, which ranges from 30 to 60 inches in thickness. The immediate roof is shale overlain by massive limestone 3 to 4 feet in thickness. To the southeast near Dahinda, T. 11 N., R. 3 E., one drill record reports a 33-inch coal at a depth of only 30 feet. It is improbable that so little cover is found over any extensive tracts in this part of the county.

The other possibly favorable area is in the southwest part of the county between Knoxville and St. Augustine, underlain by the Colchester (No. 2) coal and locally by the Rock Island (No. 1) coal. Along stream flats and to some extent in the upland areas, coal 24 to 30 inches thick may be present at depths less than 40 feet. So few records of drilling are available, however, that it is not possible to say to what extent the coal is present. No estimate of tonnage available for stripping in Knox County has been made.

MARION COUNTY

Described on page 57.

PERRY COUNTY

Including within its boundaries somewhat more than 30 miles of the line of outcrop of the Herrin (No. 6) coal, Perry County appears to hold some of the most promising areas for stripping in the State (fig. 6). Although not determined with great accuracy, the boundary of this important bed is mapped to lie within the following townships: T. 5 S., Rs. 1, 2, and 3 W.; T. 6 S., Rs. 1, 2, 3, and 4 W. The rather extensive field for exploration results from the presence of the Duquoin fold, which trends approximately north and south through the eastern part of the county near Duquoin, and brings the Herrin coal near the surface all along the crest. The effect of this structure is better understood when it is realized that the coal which practically outcrops at Duquoin lies 400 feet beneath the surface three miles to the east.

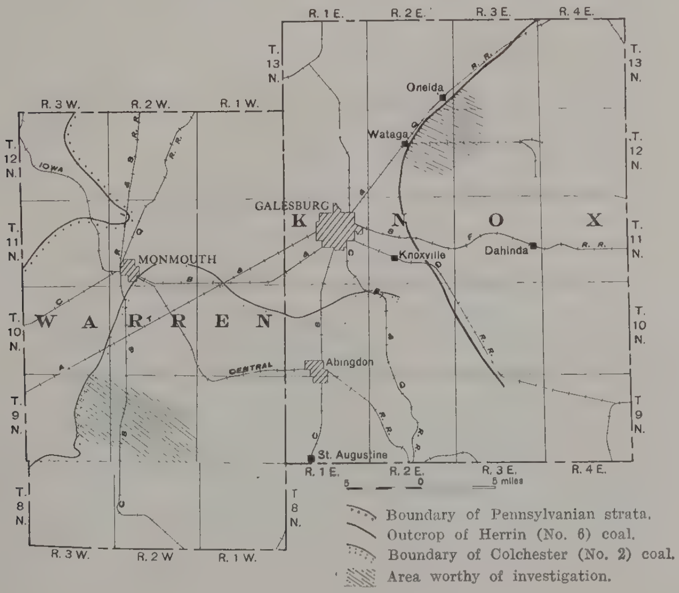
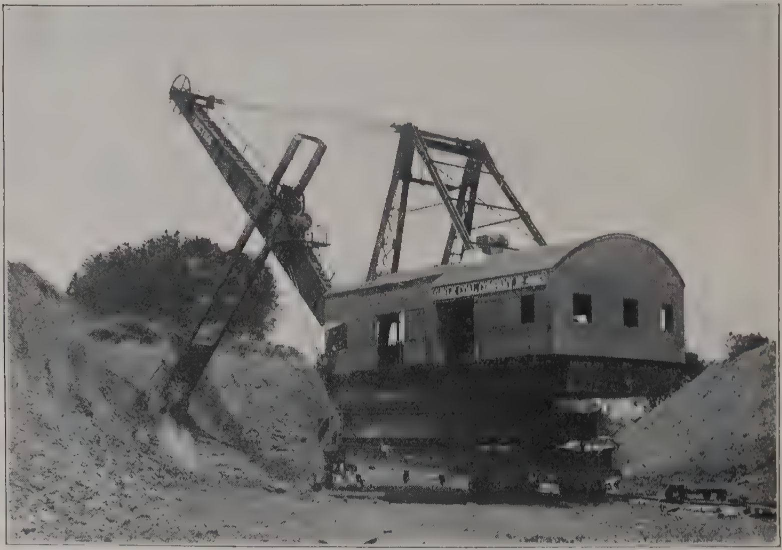


FIG. 9. Index map of Warren and Knox counties.

Throughout most of the outcrop area in this county, the Herrin coal is about 72 inches thick, slightly thinner on the crest of the Duquoin fold, and reaching a maximum of 96 inches down the dip to the east. Drilling has shown the presence of some erosion channels in the Pennsylvanian beds and in places the coal itself is cut out. In general, however, the presence of the coal in its regular thickness can be counted on for mining. The coal in the western part of the county differs from that on the east side of the Duquoin fold, where it is thicker and contains less dirt and a smaller percentage of sulphur. The shale band known as the "blue band" is everywhere present; partings of charcoal and pyrite are not rare, although none of them are especially persistent. The bed commonly shows the division into three benches, of which the top bench is commonly the best coal, the middle being softer, and the bottom containing more impurities.



Courtesy of Gayle Coal Company.

FIG. 10. Stripping equipment at Duquoin pit.

The overburden is fairly uniform where traced along the outcrop, and shows the expected variations in thickness and character back of the outcrop. Thus, at the edge the cover is the shale and limestone roof with glacial materials above, and farther back the amount of bed rock increases as the coal dips northward beneath the surface. Throughout the area mapped for exploration, the cover is probably less than 60 feet thick. Because of the small amount of information available, it is probable that local variations from this maximum will be found. It is not unlikely that considerable areas of relatively thin cover may be proved up.

Immediately over the coal is shale, commonly black and sheeted, but in places gray and slightly sandy. This averages about 3 feet thick, but is reported to reach a thickness of 23 feet in places. Over the shale is the cap limestone 2 to 5 feet thick overlain by shale and thin limestone beds. Figure 10 shows the character of the overburden where it includes about equal amounts of loose and bed rock material.

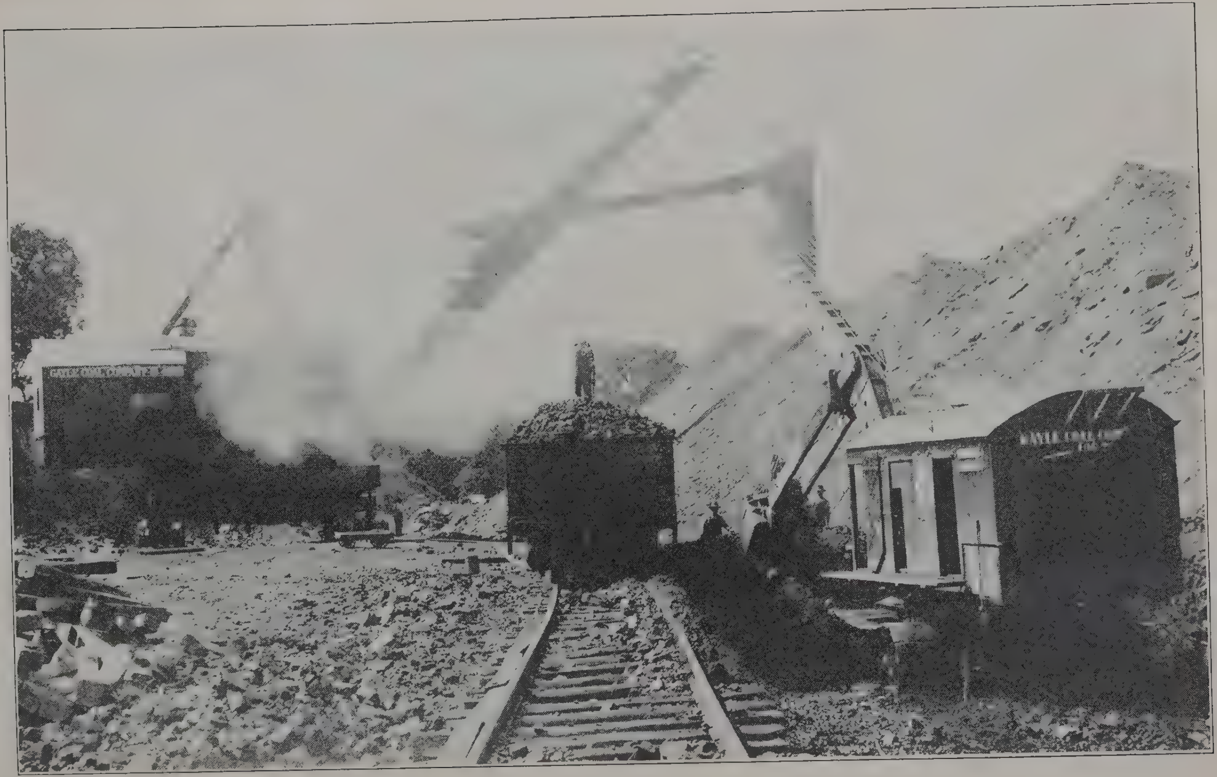
Two commercial pits are now being operated in Perry County. These are both on the crest of the fold, and hence show essentially identical conditions and character of coal. At the north pit the stripping is done with an electric shovel having a 6½-yard dipper on an 86-foot boom. The stripping shovel makes north-south cuts, working eastward across the property. A bulldozer followed by shoveling and sweeping gangs finishes the cleaning of the surface of the coal, which is then shot with a "strip special" powder. A 2-yard electric shovel (fig. 11) loads the coal into railway cars in the pit, which are hauled to the sidings to await shipment. As the coal is used as railroad fuel, it is sent out as mine run without screening. Where measured, the overburden included 9 feet of till underlain by 1 foot of shaly sandstone, 2 feet of black shale and 8 feet of very argillaceous sandstone, practically shale. On the east side of the property boulders of limestone were encountered, which represented the usual cap of the Herrin bed. These are reported to have come in above the upper sandstone.

The top coal had been removed and the base was not exposed in the following measured section:

	Thickness *Inches*
Coal, practically all bright, some calcite facings	8 6/8
Pyrite lens 8 inches long	7/8
Coal, alternately dull and bright	27
Pyrite lens 5 inches long	6/8
Coal	3
Charcoal parting	3/8
Coal, with small pyrite balls and lenses	30
Total	70 3/4

Pope County

Described on page 58.



Courtesy of Gayle Coal Company.

[illegible] Duquoin pit, Perry County

RANDOLPH COUNTY

Conditions in Randolph County are practically identical with those of St. Clair County to the northwest. The heavy overburden of glacial deposits prevents precise delineation of the line of outcrop of the Belleville (No. 6) coal, and the eastward dip of the Pennsylvanian strata carries the coal within short distances from the outcrop beneath too heavy an overburden of bed rock for stripping (fig. 12). From available data, however, the following townships appear to be underlain by coal at shallow depths:

T. 4 S., R. 6 W.
T. 5 S., R. 6 W.
Twps. 5 and 6 S., R. 5 W.

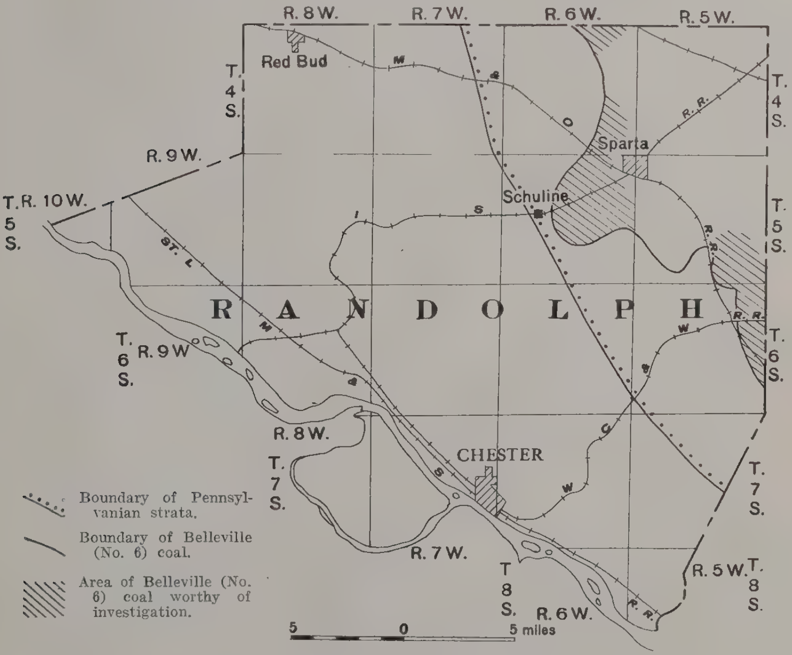


FIG. 12. Index map of Randolph County.

Some testing has been done in T. 5 S., R. 6 W., but no commercial opening has been reported.

The Belleville coal in this field is approximately 72 inches thick. The "blue band" or shale parting in the bottom third of the bed is everywhere present and the coal shows the same quality that marks it in the Belleville district.

The overburden is similar to that in St. Clair County. Below surficial materials of variable thickness the bed rock cover includes the roof shale, having a maximum thickness of about 5 feet, the cap limestone, about 3 feet thick near the outcrop but thicker a short distance eastward, and overlying shale up to more than 40 feet. Locally a second limestone several feet thick overlies the thick shale bed, and the top of the section toward the west includes a sandstone in places. In prospecting, it must be recognized that the conditions of deposition following the period of coal formation were variable in short distances, so that uniformity of overburden is not to be expected and relatively close spacing of tests will be necessary to show the actual conditions.

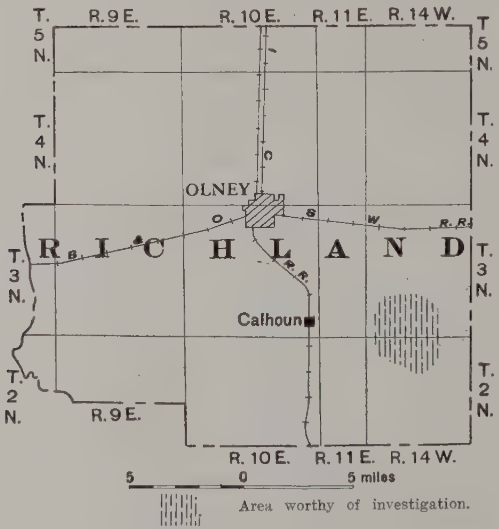


FIG. 13. Index map of Richland County.

RICHLAND COUNTY

Little testing has been reported from Richland County, and the general relations of the coal underlying the surface is not known in any detail. Sufficient work has been done to show that in some parts of the county, notably near the boundary between Tps. 2 and 3 N., R. 14 W., a thin coal lies at workable depths (fig. 13).

Lack of detailed data prevents the correlation of this coal with others in the general Illinois section, but the available evidence indicates that the coal in this field is rather high in the section, that is, above the Herrin (No. 6) bed rather than below it.

In sections measured, the coal ranged from 22 to 26 inches in thickness. It is not clear that the coal at any point will greatly exceed 36 inches. The bed is relatively clean, and shows well developed cleat, so that it breaks into rectangular blocks which are readily handled without much breakage. Little pyrite appears in the bed itself, although the contact at the top is generally marked by a zone of mixed shale and pyrite from one to two inches thick. In places the top 2 inches is bony. Another shaly zone comes in locally about 6 inches from the bottom. The bedded impurities loosen readily from the coal, and in general cause little trouble.

The roof materials vary in different parts of the field. The immediate cover of the coal is uniformly shale, although it ranges in thickness from less than 1 inch to several feet. Where thin, it is little more than clay, but in the thicker portions it is massive and locally so gritty that it might properly be classed as sandstone. It should not, however, give any serious trouble in removal. In the upland areas, the thicker cover appears to include a limestone bed immediately over the thin clay above the coal. This limestone is as variable in thickness as it is in occurrence, appearing as a row of concretionary boulders in some places, elsewhere as a massive bed nearly 4 feet thick. It is medium to dark gray in color, finely crystalline, and contains abundant fossils. In the limited area mapped as probable strip land in Richland County, the cover is probably not greater than 35 feet in thickness. Too little is known at present of the extent of and the depth to the coal to indicate even tentatively any extensions of the area mapped. On the other hand, the topography of the adjacent region, especially to the east and west, is such that if the coal maintains an essentially horizontal attitude it may be workable by stripping methods at least as far east as the Lawrence County line, and perhaps as far west as Clay County.

Within the past two years a local pit has been operated just east of Calhoun. No attempt at extensive production is being made, although the local needs of the county are well met. The cover is removed by a steam shovel operating a 4-yard dipper on a 70-foot boom. Straight north-south cuts are planned for the shovel, the overburden being placed in the cuts from which the coal has been removed. The coal is wedged and loaded by hand, and the impurities are picked out as the loading proceeds. By this method, the product is largely lump, and but little loss through slack is sustained.

SALINE COUNTY

Conditions in regard to strip mining are much the same in Saline County as in Williamson County to the west. One important point of difference should be emphasized. The Herrin (No. 6) coal is of little consequence in Saline County, as it is generally too thin to be valuable, while the Harrisburg (No. 5) coal is thicker and of better quality.

The surface cover prevents accurate determination of the line of outcrop of either bed, and hence the lines mapped are subject to later correction. As mapped, the outcrop line of the Herrin coal may be followed across the county in an east-west line near the middle of T. 9 S., Rs. 5, 6, and 7 E. (fig. 20), and that of the Harrisburg coal lying about 125 feet lower crosses the county similarly but nearer to the boundary between 9 and 10 S. Because of the rather sharp dip and the consequent increase in thickness of cover toward the north, the belt in which the Harrisburg (No. 5) coal can be profitably stripped appears to be narrow, but drilling may show it to be considerably wider than indicated on the map (fig. 20). It is obvious that the limit of stripping coal is closely related to the rather rough topography of the area, which, if the variable dip of the coal bed is considered, may cause either enlargement or reduction of the stripping field.

The Harrisburg coal is commonly described as bright and hard. Very thin bands of glance coal alternate with somewhat thicker bands of dull coal, and charcoal layers up to 1 inch in thickness appear at intervals throughout the bed. In general, it is somewhat brighter than the Herrin coal, and is somewhat harder, but it is doubtful if physical appearance serves to distinguish coal from the two beds. The Harrisburg coal ranges from 54 inches to more than 90 inches in thickness. Inspection of the available sections fails to reveal any persistent partings like the "blue band" of the Herrin bed, although a parting of clay and pyrite near the top of the bed is not uncommon.

The immediate roof of the Harrisburg bed is in most places slaty shale, less than one foot thick, and overlain by dark gray shale which locally reaches a thickness greater than 10 feet. Commonly a limestone from 3 to 10 feet thick appears within the basal 20 feet of the gray shale, and very sandy beds come in on top of this limestone. Above the bed rock is 10 to 30 feet of yellow clay, generally without boulders. In the narrow belt mapped the total cover is thought to be less than 70 feet at the maximum.

Stripping for local needs alone has been done from time to time in this field, and it is only recently that any commercial operations have produced coal. At the pit near Ledford, southwest of Harrisburg, T. 9 S., R. 6 E., the stripping is done with a steam shovel equipped with a 6-yard dipper on an 80-foot boom (fig. 14). The strip cut is from 30 to 50 feet wide, making an irregular trench trending approximately north of west and working northward across the property. The steam shovel is followed by shovel and broom gangs. After shooting, the coal is loaded with a steam shovel having a 1¼-yard dipper into 5-ton pit cars with side gates. The cars are hauled in 10- to 15-car trips by steam locomotives. The pit cars dump the coal to a hopper, whence it is loaded to a pan conveyor by a reciprocating boom. From the conveyor, the coal passes over reciprocating screens giving four standard sizes and 2-inch screenings for shipment. Impurities are hand picked from the booms.

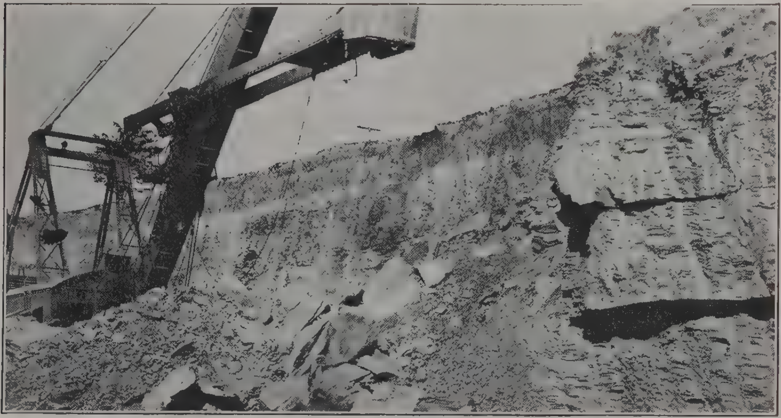


FIG. 14. Shovel making stripping cut at Ledford. Courtesy of Harrisburg Coal Mining Company.

FIG. 15. Maximum overburden at the Ledford strip pit. Courtesy of Harrisburg Coal Mining Company.

The coal bed in this pit thins from a maximum of 108 inches at the east to a minimum of 72 inches at the west. The bed lies essentially flat, and is remarkably regular except for the gradual change in thickness.

The overburden handled here includes about 40 feet of gray gritty shale of rather irregular bedding with some 20 feet of yellow clay above it (fig. 15). The latter stands well when undisturbed, but is inclined to slump into the pit from the spoil-bank in rainy weather.

West of Saline County in T. 9 S., R. 4 E., and possibly in the northeast part of T. 10 S., R. 4 E., Williamson County (fig. 20) there is probably a continuation of the outcrop line of the Harrisburg coal. Here also the conditions are possibly favorable for stripping, but the extent or thickness of the coal can not be determined from available data.

Similarly east of Saline County in T. 9 S., R. 8 E., Gallatin County there is probably an extension of the strip areas, but how far the coal is thick and under thin cover is not known. Some of this field is tentatively mapped as probable strip land.

The Herrin (No. 6) coal, lying stratigraphically above the Harrisburg bed is also present in the north half of Saline County. In general, it is thinner than the Harrisburg coal in Saline County, and although available in limited areas for stripping, will probably not be commercially as important as No. 5. The few available records show this coal to be less than 5 feet thick, commonly less than 3 feet, and to dip northward so that it is too deeply buried for stripping within a short distance from the outcrop. Except for less thickness, the conditions for this bed are similar to those described for the main field in Williamson County.

Schuyler County

The most favorable area for stripping so far reported from Schuyler County lies in the south half of T. 2 N., R. 1 W., north and east of Rushville (fig. 16). Elsewhere, although the county is quite generally underlain by the Colchester bed, except along the drainage lines of Crooked and Sugar creeks, the only probable strip sites will be found along stream valleys near the line of outcrop.

The Rushville coal has been tentatively correlated with the Springfield (No. 5) bed of Fulton County. It ranges from 57 to 78 inches in thickness, and averages about 66 inches. No regular parting or band is reported in the bed. Although it is affected by "clay-slips" in some places, they are not large, so far as known, and do not cause much trouble in mining. The coal itself is soft, of easy and irregular fracture, and has a dull luster because of the few bands of glance coal in the bed.

The immediate roof is black shale, with a thin limestone cap. Over these is sandy shale, and in the eastern part of the field some thicker limestones have been reported in drill logs. Till of variable thickness overlies or replaces the bed rock. The maximum cover reported is 90 feet, but over large areas it is probably less than 60 feet.

Examination of the map (fig. 16) will show that several small areas in the western part of the county have been indicated as possibly worthy of testing. These are merely typical of the region in general, and no attempt has been made to include all of them. In general this coal, the Colchester bed, is too heavily covered in the upland areas to make stripping possible. Along some of the streams, however, and especially near the line of outcrop, areas of 160 acres extent may be found where the cover is less than 25 feet. It is unlikely that any commercial pits can be operated in this coal in Schuyler County under present conditions.

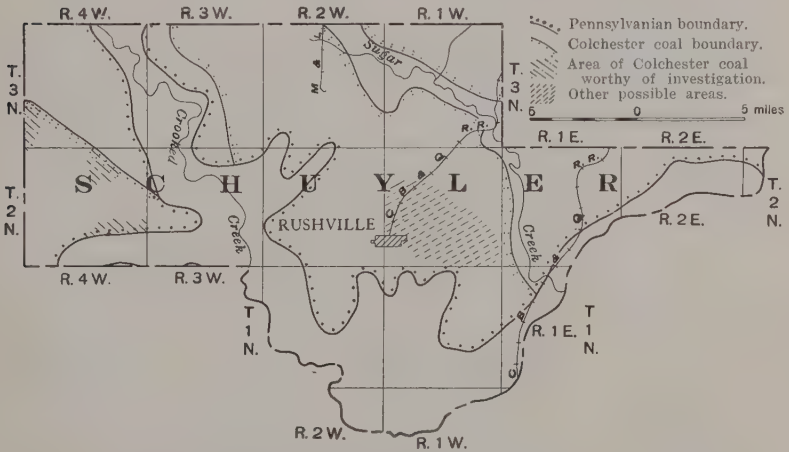


FIG. 16. Index map of Schuyler County.

ST. CLAIR COUNTY

The western limit of the Belleville (No. 6) coal passes in a southeasterly direction across St. Clair County. Because of the thick cover of unconsolidated material and the eastward dip of the Pennsylvanian beds, however, very little of the area underlain by this valuable coal can be classed as strip land. The coal appears to lie at shallow depth in two narrow fields just east of the outcrop, first, in T. 1 S., Rs. 7, 8, and 9 W., an area between Freeburg and Millstadt, and second, in T. 3 S., Rs. 6 and 7 W. in the vicinity of Marissa and Lenzburg (fig. 17). In each area, the Belleville coal ranges from 60 to 84 inches, and shows the three benches which characterize it in this part of the State. The top 12 to 24 inches is commonly the purest coal of the whole bed; the middle or thickest bench, is commonly duller than the rest and contains numerous bands of dirt, pyrite, and charcoal; the bottom bench, below the "blue band", is extremely variable in composition and ranges from 12 to 24 inches in thickness. In places it is little more than carbonaceous shale, although elsewhere it is as good as the middle bench.

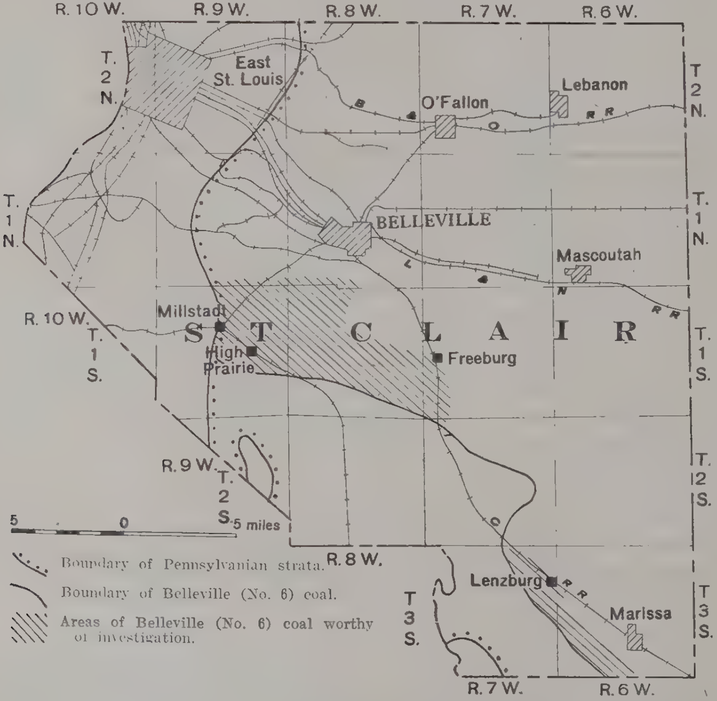


FIG. 17. Index map of St. Clair County.

Below the surficial materials, the coal is covered by bed rock of increasing thickness as the bed is traced eastward. This includes the black shale roof and the cap limestone, above which lies thick hard shale. The roof shale ranges from 8 feet to less than an inch in thickness within relatively short distances and the limestone cap shows nearly as great variation. Near the outcrop of the coal, the overburden rarely includes any bed rock above the cap limestone, but farther east the upper shale is prominent. In the vicinity of Millstadt, the cover is less than 35 feet and it is probable that other fields may be found in which similar conditions obtain.

Early in the preceding decade, a single operation in St. Clair County was producing at the rate of more than 15,000 tons annually. No information is at hand regarding the details of the methods of handling either the overburden or the coal. Within the past year, some acreage west of Freeburg has been taken up and equipment for a commercial pit may soon be installed.

VERMILION COUNTY

In no county in the State has stripping been so important as in Vermilion County. Here were worked out many of the improvements both in equipment and the method of working which have made it possible at the present time to strip coal that earlier was far too deeply buried for such recovery. Geologic reports for Vermilion County show the outcrop lines of the Danville (No. 7) and Grape Creek (No. 6) coal beds drawn in a general north-south direction through T. 20 N., R. 12 W.; T. 19 N., Rs. 11 and 12 W.; T. 18 N., R. 11 W., and T. 17 N., R. 11 W. (fig. 18). Is some places this outcrop is accurately determined; in others the overburden prevents detailed mapping. Along the main channel of Vermilion River, both coals are above drainage, but upstream above the main fork, the westward dip of the coal beds carries them well below drainage and also below too great a thickness of overburden for stripping. It is mainly along the widened river valleys that stripping is practicable, and in the thirty-five years that mechanical stripping has been practiced in this field, a large percentage of the available strip land has been worked. On this account, the Vermilion County field is of interest more for its historical background than for its probable place in the coming development of the stripping industry.

Two coal beds underlie the Vermilion County field, and each has been worked by stripping methods. The upper bed, commonly called the Danville coal and correlated as the No. 7 in the Illinois section, ranges in thickness from about 36 inches to more than 60 inches in the stripping area. The bed varies locally in thickness, especially where the bed rock cover has been removed and the glacial drift lies directly over the coal. In some places, a shale parting not unlike the "blue band" of the No. 6 coal, divides the bed into two benches. As a rule, the partings are not as persistent as in the lower bed. Pyritic masses of various sizes are especially abundant in parts of the bed. Equipment for operating and cleaning this material was installed in one plant, and during the war period the demand for sulphuric acid provided considerable profit on this by-product. Of late years, this separated material has not been marketed.

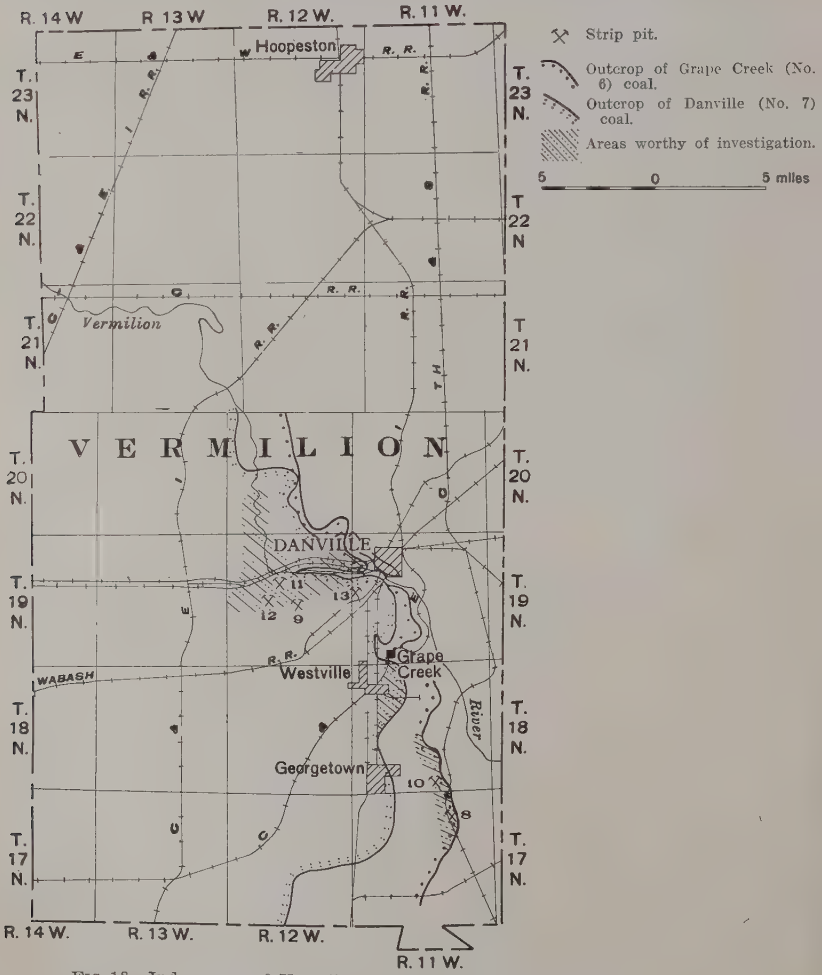


FIG. 18. Index map of Vermilion County. Figures accompanying strip pit symbols refer to mines listed in Table 1.

The roof of the Danville bed is commonly black shale of variable thickness, overlain by gray shale which in places reaches a thickness of more than 50 feet. Its thickness in the stripping field depends upon the extent of erosion that the area has undergone. Above the bed rock is the usual glacial drift of the region. Where untouched by stream erosion, this is generally too thick for removal by shovels. The stripping areas are largely restricted to the vicinity of the larger stream channels.

The Grape Creek (No. 6) coal in the probable stripping area is generally more than 72 inches thick. It commonly lies in two benches separated by the shale parting known as the "blue band", which comes somewhat below the middle of the bed. The two benches are not unlike, consisting of alternating dull and bright layers with interlaminated charcoal, dirt, and pyrite. The Grape Creek coal has in most places a smaller amount of impurities than the Danville bed.

In the stripping area, the bed rock over this coal is shale, although in the immediate vicinity of Danville there is a persistent limestone caprock somewhat above the coal. The more common shale is relatively unconsolidated, and is readily handled by the shovel.

Six commercial pits are now being operated in Vermilion County, four of them working the Danville coal, and two working the Grape Creek bed. In the westernmost of these pits, the stripping is done with a steam shovel operating a 6-yard bucket on an 80-foot boom. The coal has been stripped in a series of east-west cuts, working northward to a limit fixed by former underground mines long since abandoned. Shovel gangs finish cleaning off the coal, brooms being used only when necessary. The coal is then shot with black powder, loaded into 5-ton pit cars with a standard steam shovel using a 1½-yard dipper. The cars are hauled by 20-ton steam locomotives in trips of twelve to the foot of a long incline leading to the tipple at the top of the bluff. On account of the long steep pull, the pit cars are handled one at a time up this incline. At the tipple, most of the coal is passed over screens and picking tables, although some mine run is also marketed. Water in this pit is pumped over the spoil bank to the main drainage line of the region.

The overburden, though thinner near the river valley to the south and east, is rather uniformly about 35 to 50 feet where it is now being removed. It includes about 10 feet of surface soil and slightly bouldery clay and from 25 to 40 feet of light gray shale, fairly hard and usually well bedded. Practically no variations in character of overburden are met in this tract. The coal ranges from 5½ to 6 feet in thickness, and is essentially flat. The only interruptions of the bed are found where the shale roof and some of the coal have been removed by earlier erosion, producing a down-roll which in places cuts out all but two feet of the bed.

Another pit, also working the Danville coal bed, is operating two steam shovels, one equipped with a 3-yard dipper on a 70-foot boom, the other with a 6-yard dipper on a boom about 80 feet long. Throughout this pit, the stripping is done essentially along lines which parallel the drainage of the area, the limit of stripping is determined by the main valley walls, back of which the overburden is too great for present methods and equipment. Shovel gangs follow the stripper, and the coal is loaded out to 5-ton, side gate, pit cars with a 1½-yard steam shovel. The pit locomotives carry about fifteen cars in a trip to the foot of a long incline leading to the tipple, which is situated along the railroad track at the top of the bluff. Cars are hauled up the incline by a cable in trips of four. At the tipple, they are dumped into a hopper which feeds the coal on to an endless steel conveyor by which it is carried to the screens. On this first conveyor, the larger lumps are sledged and two pickers remove impurities. After screening, the coal again passes over picking tables before being loaded by booms to railway cars below. This tipple was equipped during the war period for separating and cleaning the pyrite which occurs rather abundantly throughout the coal bed. Since the demand for this material has lessened, it is merely separated and buried to prevent firing.

The coal in this pit ranges from 5 to 6 feet in thickness, and although it includes the many impurities of pyrite and shale characteristic of this bed, no regular partings are recognized. The overburden is extremely variable, depending on the location of the cut with reference to the valley. In much of the middle portion of the valley, there is as little as 6 feet of shale immediately overlying the coal, with perhaps no more than 12 feet of till or alluvial sands above. As the shovel approaches the main valley wall, however, the overburden changes in character and increases in thickness. At points where maximum cover is removed, the cut shows as much as 15 feet of surface material, including some bouldery clay and 35 feet of light gray shale, well bedded and rather hard.

In working the Grape Creek coal southeast of Georgetown, the overburden is handled with a steam shovel operating a 5-yard dipper on an 80-foot boom. The coal is recovered from a stream valley, and, as usual in such situations, the direction of cut is determined by the topography of the field. The shovel gang completes the cleaning of the coal, as sweeping is usually unnecessary because of the character of the overburden. The coal is loaded out with a steam shovel using a 1½-yard dipper. Pit cars of 5-ton capacity with side gates, and running on a 36-inch track are hauled out in trips of four to the tipple at the west end of the pit. The coal is dumped into a hopper, thence fed to a steel conveyor, by which it is taken to screens and picking tables. Two sizes are made in this mine; all coal passing one-inch bar screen is classed as lump and the rest as screenings. Lump coal is loaded over booms, the screenings through chutes. The overburden in this pit varies as different parts of the valley are worked, but on the average shows from 10 to 15 feet of surface material with perhaps a maximum of 25 feet of shale below. The coal bed averages about 5 feet in thickness and commonly shows some pyrite and shale partings.

WABASH COUNTY

Wabash County has never been more than a local producer of coal, for the known beds are thin or lie deeply buried. In the south central part of the county, however, a coal of moderate thickness appears to lie at shallow depth in T. 1 N., Rs. 12, 13 and 14 W., and in Tps. 1 and 2 S., Rs. 13 and 14 W.

The only coal in the county which appears to be workable by stripping methods is the thin bed known as the Friendsville coal, which has been mined in wagon pits near Friendsville, Maud, Bellmont and Keensburg. It has been reported generally at shallow depths elsewhere in this field, so that its area is fairly well known. At the north, however, the limit is not fixed, and the coal is possibly continuous with the similar bed near Calhoun in Richland County.

In Wabash County, the Friendsville coal ranges from less than 12 to more than 48 inches in thickness, and perhaps does not vary much from 36 inches over most of the area mapped (fig. 19).

In this field, the cover ranges from less than 10 feet to more than 65 feet. It is believed that along the rather wide stream valleys of the region, considerable tracts will be found in which the coal lies at less than 35 feet below the surface.

The roof of the coal is commonly gray shale but where the bed rock cover is thick, the shale may be topped by sandstone. Locally, as reported in a few tests, the coal is accompanied by a limestone roof and this, too, is in places overlain by sandstone. In these variations, the Friendsville coal closely resembles the Calhoun bed which is mined a few miles to the northwest.

So far as has been reported, this bed has not been stripped, and no analyses are at hand to indicate its composition. From early reports, the coal appears rather high in impurities, so that the yield of ash is large. It burns rather freely, but does not coke.

WARREN COUNTY

Warren County shows but little territory which appears to be valuable as strip coal property. In general, the coals of the county are thin and rather too deeply buried to be accessible to the shovel. In the southwestern part of the county, however, especially in the east half of T. 9 N., R. 3 W. and in most of T. 9 N., R. 2 W., the conditions seem to warrant testing (fig. 9, p. 33).

There are two coals under part of these townships, the upper being the Colchester bed and the lower, a thicker bed, tentatively correlated with the Rock Island bed. It is possible that there are small tracts in which both coals may be stripped, since the interval between them ranges from 40 to less than 20 feet.

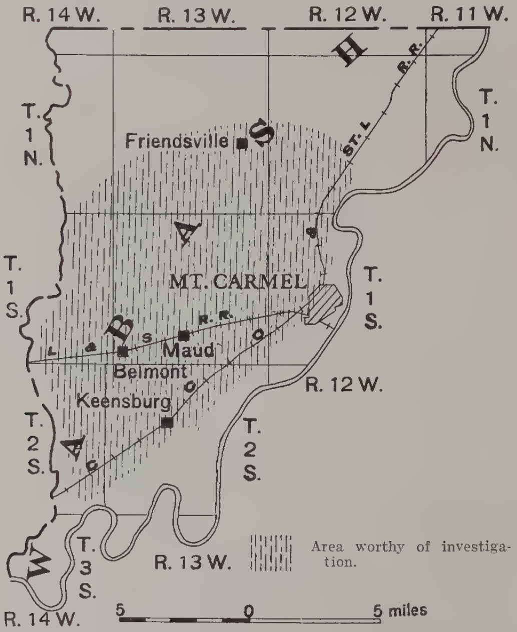


FIG. 19. Index map of Wabash County.

The Colchester coal appears to maintain a rather uniform thickness of 24 to 30 inches in the area above noted, although on account of its somewhat irregular distribution, it may be thinner locally. All preliminary testing should take account of this probable variation. The coal is of fair quality in most places, mostly dull with but few bright bands, but shows no persistent partings of shale or bone. Facings of calcite and gypsum and small lenses of pyrite are common.

The overburden consists of a rather massive shale roof and till. The shale commonly includes a band of black fissile shale but is more sandy in the upper part than below, commonly grading laterally into sandstone. It is not believed that this stratum will seriously interfere with stripping operations. In the area indicated on figure 9, the surface material seems to be from 5 to 55 feet thick, but it is recognized that this maximum will be exceeded locally.

The lower coal, which is present in at least the eastern part of T. 9 N., R. 2 W. is about 40 inches thick, but is relatively soft and notably laminated with prominent bright and dull bands. A bony or shale parting near the middle is usually present, and the lower bench is softer than the top. Facings of calcite, gypsum and pyrite are so common in exposures now known that the ash and sulphur content is generally high. It is not improbable that, when opened farther from the outcrop, the impurities will be of less importance, a feature which should be carefully noted in any tests for commercial operations. The overburden, obviously greater than that of the Colchester bed, is essentially the same as that noted for the upper bed, with the additional bed rock which normally intervenes between the two coals. This interval at the maximum includes about 30 feet of shale below the Colchester bed, and from 2 to 8 feet of limestone coming between that shale and the roof clod of the lower coal bed. It is not probable that there are any extensive areas in which the lower bed can be stripped.

Wayne County

Described on page 57.

Will County

Described on page 26.

Williamson County

Williamson County includes between thirty and forty miles of the outcrop line of the Herrin (No. 6) coal, and an unknown amount of the outcrop line of lower beds such as the Harrisburg (No. 5) and the Murphysboro (No. 2) coals. Since the areas in which these lower beds may perhaps be stripped can not be defined on present data, this report will deal with the Herrin bed only. Some mention of the Harrisburg coal was made in connection with the discussion of that bed in Saline County.

Because of the relatively steep northward dip of the Pennsylvanian beds in this part of the State, the stripping area for the Herrin coal is limited to a narrow belt just north of the outcrop line. The cover of glacial drift in this county, as elsewhere in the coal fields of Illinois, renders it difficult to determine the limit of any coal bed accurately. Particularly in the area between Herrin and Crab Orchard Creek valley to the south are the relations indefinite.

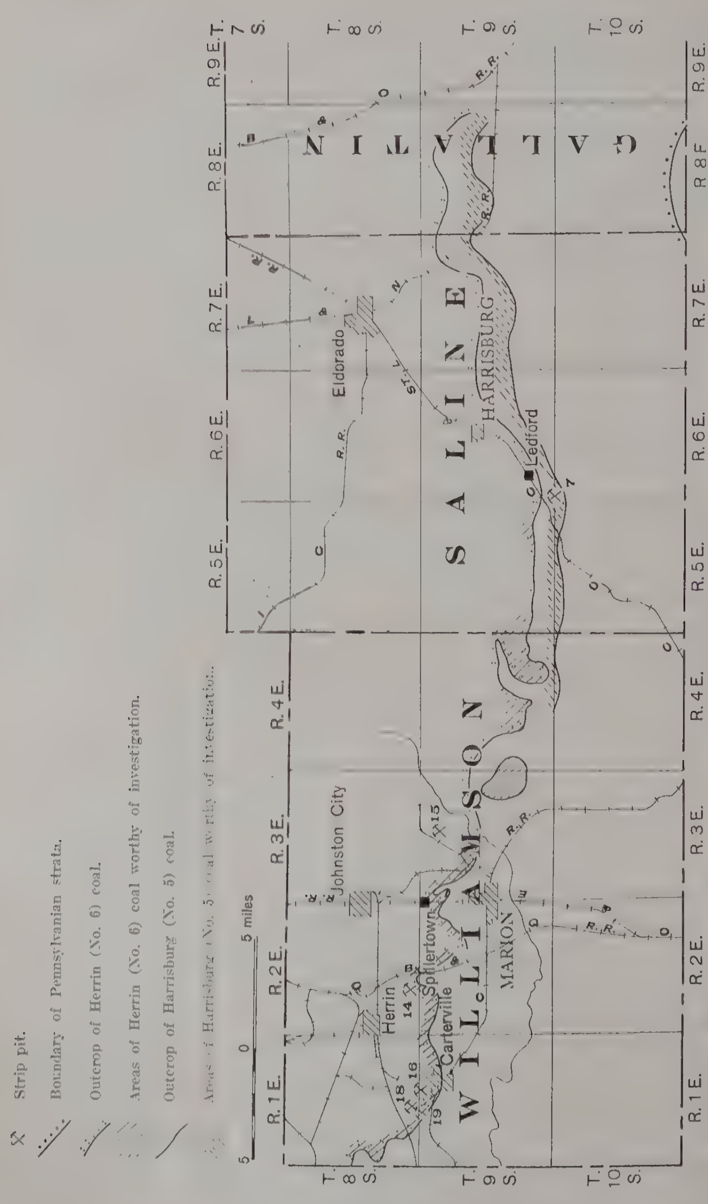

X Strip pit.
Boundary of Pennsylvanian strata.
Outcrop of Herrin (No. 6) coal.
Areas of Herrin (No. 6) coal worthy of investigation.
Outcrop of Harrisburg (No. 5) coal.
Areas of Harrisburg (No. 5) coal worthy of investigation.
5 0 5 miles
R.1E.
R.2E.
R.3E.
R.4E.
R.5E.
R.6E.
R.7E.
R.8E.
R.9E.
T. 7 S.
T. 8 S.
T. 9 S.
T. 10 S.
WILLIAMSON
SALINE
GALLATIN
Herrin
Carterville
Spillertown
MARION
Johnston City
Eldorado
HARRISBURG
Ledford
14
15
16
18
19
7
R.R.

Fig. [illegible]. Index map of Williamson, Saline and western Gallatin counties. Figures accompanying strip pit symbols refer to mines listed in Table 1.

With the above modification, the following townships may be considered as including the outcrop of the No. 6 coal in such relations of thickness and cover as to be worth testing for stripping purposes: T. 8 S., R. 1 E.; and T. 9 S., Rs. 1, 2, 3, and 4 E.

Throughout practically all of this field, the coal is 72 inches or more in thickness, although in some pits it averages as much as 84 inches. As elsewhere, on account of pre-glacial erosion, the coal is thinner and shows greater variation in thickness near the outcrop than farther back. The following descriptions of this coal now mined so extensively underground in the northern part of this county and in Franklin and Jefferson counties is generally applicable to this field.[1]

"The coal is shining black, commonly banded, and on close inspection appears laminated with alternating bright and dull lines. A 'blue band', or dirt band, found almost everywhere 18 to 30 inches above the floor, generally consists of bone or shaly coal or of gray shale. Its thickness varies from one-half to 2½ inches with an average of about 1⅔ inches.

"A clean persistent parting of mother coal lies 14 to 24 inches below the top of the bed and a second parting generally appears 5 to 8 inches down. Above the upper parting the coal is in layers 3 to 6 inches thick, with partings of mother coal between them. Local lenses of mother coal, 6 inches to 5 feet in length and 1 to 4 inches thick, are common in the upper third of the bed. Small pyrite lenses and streaks of bone, a few inches to a foot or more in length and one-fourth to 1 inch in thickness are found here and there in the middle portion of the bed, a short distance above the 'blue band'. In the middle and lower parts of the bed the lamination is less distinct but the bedding is still evident."

The cover of the Herrin (No. 6) coal near the line of outcrop is similar to that described for Jackson County on the west. In the area mapped for testing (fig. 20), the cover is believed to be less than 70 feet thick. The glacial drift, including some boulder clay but more commonly fine clay without stones larger then pebbles, ranges from about 5 to 25 feet in thickness. Near the margin of the coal bed the cover is about half of surficial and half of bed rock materials. As the deeper part of the field is entered, the increased thickness of cover includes a greater proportion of bed rock.

The immediate cover of the coal is normally 3 feet of black shale, slaty in places. Above this is the cap limestone, ranging from a thin stratum of boulders to a massive bed more than 5 feet thick. The limestone is overlain by another bed of shale more or less sandy and grading to sandstone in places. In some pits, clay shale comes in between the coal and the slaty black shale. Near Spillertown, T. 9 S., R. 2 E., this gray shale is commonly in the form of lenses, but elsewhere, as near Carterville, T. 9 S., R. 1 E., it is a thick massive bed, and no other strata appear over the coal.

---

[1] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin Folio (No. 185), p. 14, 1912.

These several beds above the coal vary considerably from place to place, so that no standard cover can be described. Where thin, the overburden may include some 15 feet of glacial clay with an equal thickness of gray shale or of limestone and slate above the coal. Where the total cover is thicker, the glacial drift may be no heavier, but the additional overburden includes greater thicknesses of limestone and of overlying gray shale. It is believed that only rarely will areas be found in which cover is of such character as to be too difficult to remove with modern stripping equipment.

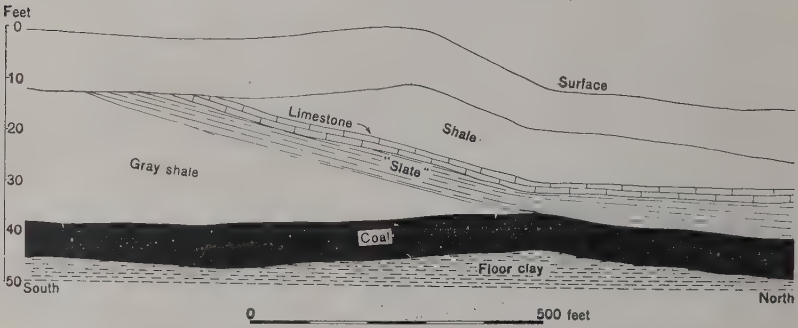


FIG. 21. Diagrammatic section of overburden in a Williamson County pit.

Stripping has been practiced for many years in this county so that equipment and mining methods vary from pit to pit. At one of the larger pits southeast of Herrin, the stripping shovel makes a straight north-south cut working westward across the property. The surface of the coal is well cleaned with shovel and broom, so that after shooting the coal can be loaded directly to the railway cars for shipment. No screening equipment has been installed at this pit since mine run only is shipped.

The coal at this pit ranges from 72 inches to 102 inches in thickness, except where part of the bed has been removed by erosion. The bed dips gently northward, but shows local rolls as much as 5 feet high. Figure 21 shows the relative positions of coal, shale, and limestone, as exposed at the time of examination of this pit. It will be noted that the shale bed just over the coal thickens to the south. Where the pit was opened, no other bed rock appeared over the coal. The coal itself has shown but little variation in character or thickness with the change in the overburden. Where measured, the bed was 8 feet thick and showed few partings except the regular "blue band" of shale about 2 feet above the floor clay.

Whatever water accumulates at the bottom of the pit is pumped over the uncut bank into the regular drainage channel of the area.

South of this pit is another which has been worked with varying degrees of success for several years. At the present time, the stripping is done by a steam shovel operating an 80-foot boom which carries a 6-yard dipper on a 58-foot dipper-stick. The plan of operations has been changed from time to time as various factors have necessitated modification of the original plan. Recently the coal has been stripped in a circular belt, the first cuts being as far from the outcrop as present equipment seemed to permit. The surface of the coal is cleaned by means of team and scraper, followed by shovel gangs. The coal is then shot with black powder and loaded directly into railway cars. With this equipment coal is loaded out at the rate of 2000 tons per 8-hour shift, the stripping shovel working three shifts.

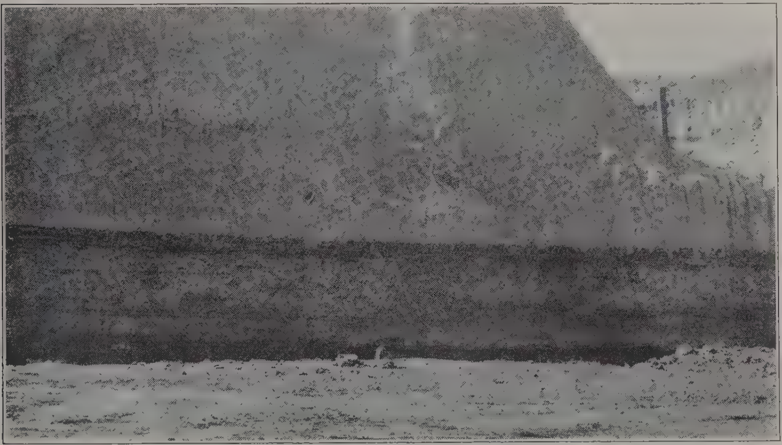


FIG. 22. Coal and overburden at Spillertown pit, T. 9 S., R. 3 E., Williamson County.

The coal bed is interrupted in this pit by a small vertical fault which trends about north 25° west and is crossed at both ends of the semi-circular pit. This is of slight consequence, except as it slows up the loading and makes it necessary for the loading shovel to spend some time cleaning up the mixed coal and shale at the fault zone. Some shifting of the track grade is obviously necessitated by the fault also.

In the Spillertown area, T. 9 S., R. 2 E., no large pits are now being worked, but several local pits are usually in operation. These commonly work on as little as ten acres, so that there may be three or four pits on a single forty-acre tract. In the main, these are wholly hand worked, the mule and hand scraper followed by sweepers or not, as the market may demand. Most of the surface dirt is cleaned off but the elimination of the hard roof shale is not as thorough. Water is usually taken care of by gasoline driven pumps.

The coal is not worked far down the slight northeast dip, since the stripping equipment does not permit handling any great thickness of overburden economically. The exposures examined show coal from 6 to 8 feet thick, about 3 feet of black fissile shale with highly weathered limestone nearly 10 feet thick, and from 5 to 15 feet of surface clay on top. Figure 22 shows the general appearance of the pits in which the bed rock cover is slight and includes no limestone.

Other Counties

GENERAL STATEMENT

As stated in the general discussion earlier in this report, some of those counties lying outside the main producing fields of the State are known to contain more or less extensive deposits of thin coal at depths which in general are slight enough to permit stripping. These beds have been worked in a small way for a great many years, but little or no systematic drilling has been reported so that their actual extent is not known. Commercial operations have not been started in any of these counties, nor does it seem likely that any will be in the near future. On the other hand, some of these deposits may be of value in meeting the present local needs of communities commercially less accessible to present coal production, and certainly will be important in the future when the thicker coal beds are worked out.

The coal immediately below the surface material throughout these minor fields is uniformly thin, ranging from a few inches to a little more than 3 feet. In general, the deposits are less than 24 inches thick, but further drilling may show greater average thickness in places. The beds are essentially flat lying when large areas are considered, but within a given township or even a single square mile, considerable difference in elevation may be noted. The coal lies in a series of irregularly shaped, nearly discontinuous basins, so that several distinct fields may be found within a single county. In places the coal has been found to be of excellent quality. Elsewhere, even within a short distance, it has been found to vary from good to very poor grade, with abundant partings of shale or pyrite. In other words, these deposits exhibit the variation in both chemical and physical properties which are to be expected in coals of local deposition in small swamps where conditions were not uniform either over large areas or during long periods of time.

Comparable to variations in the coal bed are the differences in roof conditions. Shale is the most common roof for these beds of thin coal, but it may be sandy, or slaty, or soft and massive. Locally, the roof is sandstone or in a few places limestone.

EFFINGHAM AND CLAY COUNTIES

A coal which Worthen called No. 16 of the general coal section, lies beneath relatively light cover in the southwestern portion of Effingham County. It has been reported 36 inches thick, but where measured, proved to be less than 24 inches. The bed dips eastward so that it is too deep for stripping a short distance from its outcrop. The overburden is variable in character, locally including calcareous black shale. In places the coal is overlain by a 4-foot limestone and loose drift. Probably the only stripping areas will be found near the drainage lines. Northwestern Clay County may include an extension of this field.

MARION AND JEFFERSON COUNTIES

Thin coal underlies practically all of Marion County, and all but the southwest part of Jefferson County, ranging in thickness from a few inches to 2 feet. Worthen reported coal at nearly forty places in Marion County alone, and stated that the quality was "in most instances very fair." With but few exceptions, he referred all these discoveries to the same coal bed. If this is the case, the deposition of coal seems to have been rather more uniform here than in Effingham and Clay counties to the northeast. The overburden includes black sheeted shale with limestone overlying it in places. Elsewhere, the black shale grades upward into softer shale, capped by sandstone. In Jefferson County, the bed rarely includes more than 18 inches of good coal, the rest being pyritic and bony. In places the bed is split by a shale parting, which locally becomes too thick to permit mining the coal.

WAYNE AND EDWARDS COUNTIES

Only a small part of Wayne and Edwards counties contains coal of any thickness suitable for stripping. In the northeast portion of

Wayne and the adjoining part of Edwards County, a coal ranging from 1 to 2 feet in thickness lies relatively near the surface, but it is commonly too deeply buried to be stripped. The bed rock overburden includes a few feet of shale with sandstone above. The surficial deposits are usually less than 15 feet in the interior of the counties, but somewhat thicker toward the east margin of Edwards County along Bonpas Creek and the Wabash. In southeastern Edwards County, a coal bed ranging from 30 to 36 inches in thickness lies at less than 10 feet beneath several small areas. The coal is reported to be hard, of splinty or semi-block grade, and is probably to be correlated with some of the beds across the Wabash in Indiana. It was tentatively regarded by Worthen as identical with his No. 13 of the Illinois section.

JOHNSON AND POPE COUNTIES

Both Johnson and Pope counties lie at the south end of the Illinois coal field, and do not appear to contain coal deposits that are especially valuable for stripping purposes, but as stripping has been done in places in them, a brief discussion is included in this report.

Coal has been stripped in sec. 32, T. 11 S., R. 3 E. and secs. 3, 19 and 32 of T. 11 S., R. 4 E., all in Johnson County. The areas suitable for stripping are limited to the rather sharply incised valleys. The coal ranges from 18 to 36 inches in thickness, and commonly lies beneath a sandstone roof. Only limited thicknesses of this rock can be removed profitably in the local stripping operations afforded by this thin coal.

In Pope County, stripping coal is known in secs. 14 and 32, T. 12 S., R. 6 E. Here, the coal outcrops along streams, and the cover is too thick for stripping, except close to the channels. The coal is about 2 feet thick, and is usually overlain by from 5 to 12 feet of dark gray shale. Where the bed rock is heavier, the cover includes several feet of sandstone.

Both of these coals are thought to lie low enough in the general coal section of the Illinois field to be at or below the horizon of the No. 1 coal.

BIBLIOGRAPHY

1907. Anonymous, A Novel Stripping Plant: Mines and Minerals, October, 1907, Vol. 28, No. 3, pp. 139-140 (Stripping of coal at Danville, Illinois).

1910. Anonymous, Stripping Coal Beds: Mines and Minerals, September, 1910, Vol. 32, No. 2, pp. 69-70 (Methods in use in the anthracite region of Pennsylvania and in bituminous coal in Illinois).

1913. Young, C. M., Strip-pit Mining with Steam Shovels: Coal Age, January 4, 1913, Vol. 3, pp. 10-12 (Kansas operation using very large equipment).

1914. Fitzgerals, P. S., Profit or Loss with Steam Shovel: Engineering Record, March 14, 1914, Vol. 69, pp. 307-308 (An analysis of the various elements that produce efficiency in excavation work and a study of their proper coordination).

1915. Anonymous, Coal Stripping in Illinois: Colliery Engineer, September 1915, Vol. 36, p. 69.

1916. Anonymous, Steam Shovel Coal Stripping in the Danville District: Coal Age, March 11, 1916, Vol. 9, pp. 448-452.

1920. Kennedy, T. E., By Charts of Stripping Progress and Cost, Operating Losses may be Forestalled: Coal Age, Vol. 18, No. 8, pp. 384-388, August 19, 1920.

1923. Anonymous, Black Diamond, Vol. 70, No. 26, pp. 764-787, June 30, 1923 (A series of articles on various phases of the stripping industry).

1924. Holmes, G., Early Coal Stripping full of Heartbreak: Coal Age, Vol. 25, Nos. 22 and 23, pp. 797-800, 835-839, May 29 and June 5, 1924.

1924. Anonymous, Legal Status of Strip Coal: Black Diamond, Vol. 73, No. 3, p. 57, July 19, 1924 (Ohio Court rules that strip coal has less heating value than deep mined coal).

1924. Brosky, A. F., Getting More Work From a Stripping Shovel: Coal Age, Vol. 26, No. 5, pp. 141-144, July 31, 1924 (Suggests separate machine for wasting spoil of shovel).

1924. Holmes, G., Strip Mines Full of Pitfalls for the Unwary: Coal Age, Vol. 27, No. 7, pp. 211-216, August 14, 1924.

1924. Davidson, E. W., "The Hartshorns" Open Big Illinois Strip Pit: Coal Age, Vol. 26, No. 10, pp. 319-322, September 4, 1924.

PUBLICATIONS

ILLINOIS MINING INVESTIGATIONS

ILLINOIS STATE GEOLOGICAL SURVEY DIVISION
URBANA, ILLINOIS

Bulletin 1. Preliminary report on organization and method of investigation, 1913.
Bulletin 3. Chemical study of Illinois coals, by S. W. Parr, 1916.
Bulletin 10. Coal Resources of District I (Longwall), by G. H. Cady, 1915.
Bulletin 11. Coal resources of District VII, by Fred H. Kay, 1915.
Bulletin 14. Coal Resources of District VIII (Danville), by Fred H. Kay and K. D. White, 1915.
Bulletin 15. Coal resources of District VI, by G. H. Cady, 1916.
Bulletin 16. Coal resources of District II (Jackson Co.), by G. H. Cady, 1917.
Bulletin 17. Surface subsidence in Illinois resulting from coal mining, by Lewis E. Young, 1916.
Bulletin 18. Tests on clay materials available in Illinois coal mines, by R. T. Stull and R. K. Hursh, 1917.
Bulletin 20. Carbonization of Illinois coals in inclined gas retorts, by F. K. Ovitz, 1918.
Bulletin 21. The manufacture of retort coal-gas in the central states, using low-sulphur coal from Illinois, Indiana, and western Kentucky, by W. A. Dunkley and W. W. Odell, 1918.
Bulletin 22. Water-gas manufacture with central district bituminous coals as generator fuel, by W. W. Odell and W. A. Dunkley, 1918.
Bulletin 23. Mines producing low-sulphur coal in the central district, by G. H. Cady, 1919.
Bulletin 24. Water-gas operating methods with central district bituminous coals as generator fuel. A summary of experiments on a commercial scale, by W. A. Dunkley and W. W. Odell, 1919.
Bulletin 25. Gas purification in the medium-size gas plants of Illinois, by W. A. Dunkley and C. E. Barnes, 1920.
Bulletin 26. Coal resources of District IV, by G. H. Cady, 1921.
Bulletin 27A. Analyses of Illinois coal, compiled by G. W. Hawley, 1923.
Bulletin 28. Preliminary report on coal stripping possibilities in Illinois, by Harold E. Culver, 1925.

ENGINEERING EXPERIMENT STATION
URBANA, ILLINOIS

Bulletin 2. Coal mining practice in District VIII (Danville), by S. O. Andros, 1913.
Bulletin 4. Coal mining practice in District VII, by S. O. Andros, 1914.
Bulletin 5. Coal mining practice in District I (Longwall), by S. O. Andros, 1914.
Bulletin 6. Coal mining practice in District V, by S. O. Andros, 1914.
Bulletin 7. Coal mning practice in District II, by S. O. Andros, 1914.
Bulletin 8. Coal mining practice in District VI, by S. O. Andros, 1914.
Bulletin 9. Coal mining practice in District III, by S. O. Andros, 1915.
Bulletin 12. Coal mining practice in District IV, by S. O. Andros, 1915.
Bulletin 13. Coal mining in Illinois by S. O. Andros, 1915. (Complete resumé of all the district reports.)
Bulletin 91. Subsidence resulting from mining, by L. E. Young and H. H. Stoek, 1916.
Bulletin 100. Percentage of extraction of bituminous coal with special reference to Illinois' conditions, by C. M. Young, 1917.
Bulletin 113. Panel system of coal mining, by C. M. Young, 1919.
Bulletin 119. Some conditions affecting the usefulness of iron oxide for city gas purification, by W. A. Dunkley, 1921.
Bulletin 125. The distribution of the forms of sulphur in the coal bed, by H. F. Yancey and Thomas Fraser, 1921.
Bulletin 132. A study of coal mine haulage in Illinois, by H. H. Stoek, G. R. Fleming and A. J. Hoskin, 1922.
Bulletin 144. Power studies in Illinois coal mining, by A. J. Hoskin and T. Fraser, 1924.

U. S. BUREAU OF MINES
WASHINGTON, D. C.

Bulletin 72. Occurrence of explosive gases in coal mines, by N. H. Darton, 1915.
Bulletin 83. The humidity of mine air, by R. Y. Williams, 1914.
Bulletin 99. Mine ventilation stoppings, by R. Y. Williams, 1915.
Bulletin 102. The inflammability of Illinois coal dusts, by J. K. Clement and L. A. Scholl, Jr., 1916.
Bulletin 137. Use of permissible explosives in the coal mines of Illinois, by J. R. Fleming and J. W. Koster, 1917.
Bulletin 138. Coking of Illinois coals, by F. K. Ovitz, 1917.

Bulletin 203. Central district bituminous coals as water-gas generator fuel, by W. W. Odell and W. A. Dunkley, 1924.
Bulletin 234. The screen sizing of coal, ores and other minerals, by E. A. Holbrook and Thomas Fraser, 1924. (In press.)
Technical Paper 190. Methane accumulations from interrupted ventilation, with special reference to coal mines in Illinois and Indiana, by H. I. Smith and Robert J. Hamon, 1918.
Technical Paper 246. Water-gas apparatus and the use of central district coal as generator fuel, by William W. Odell, 1921.
Technical Paper 268. Preparation and uses of tar and its simple crude derivatives, by W. W. Odell, 1922.
Technical Paper 284. Coal and coke mixtures as water-gas generator fuel, by W. W. Odell, 1921.
Technical Paper 304. Water-gas tar emulsions, by W. W. Odell, 1923.
Technical Paper 330. Small hose streams for fighting mine fires, by L. D. Tracy and R. W. Hendricks, 1924. (In press.)

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DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

Cooperative Mining Series

BULLETIN 29

COAL RESOURCES OF DISTRICT III

(Western Illinois)

BY

HAROLD E. CULVER

ILLINOIS MINING INVESTIGATIONS

Prepared under a cooperative agreement between the Illinois State Geological Survey Division, the Engineering Experiment Station of the University of Illinois, and the U. S. Bureau of Mines

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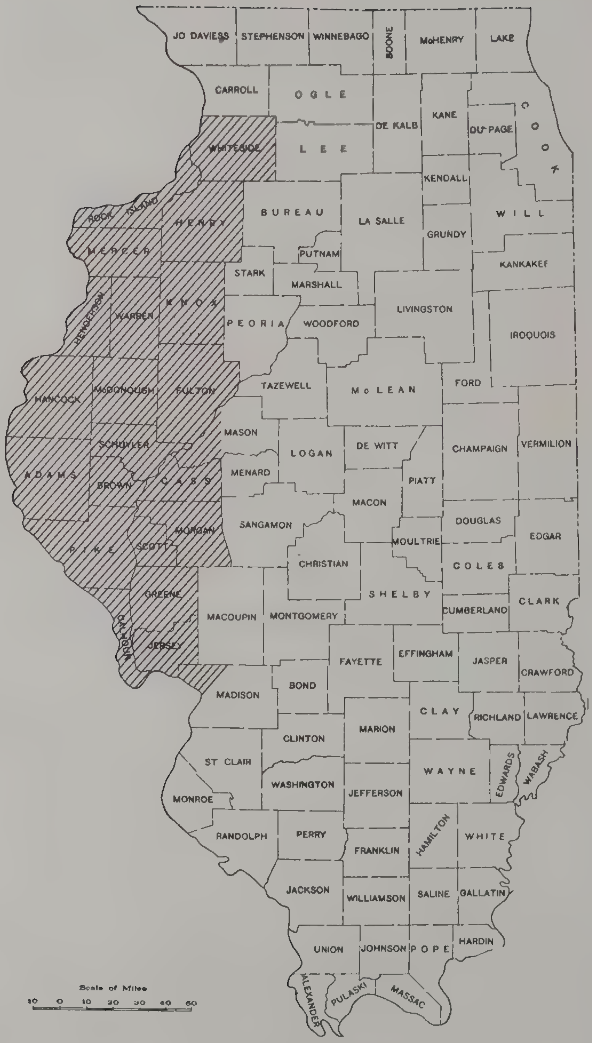

FIG. 1. Index map of Illinois showing area included in District III.

COAL RESOURCES OF DISTRICT III

By Harold E. Culver

PART I—GENERAL RELATIONS WITHIN DISTRICT III

INTRODUCTION

Importance of the Area

This report covers an area of about 11,000 square miles in the western part of the State, comprising all or parts of the following counties: Adams, Brown, Calhoun, Cass, Fulton, Greene, Hancock, Henderson, Henry, Jersey, Knox, Madison, Mason, McDonough, Mercer, Morgan, Pike, Rock Island, Schuyler, Scott, Warren, and Whiteside (fig. 1). This district, one of eight into which the State is divided for purpose of coal investigation, is defined as the area lying west of the Longwall (District I) and Springfield-Peoria (District IV) districts, and underlain by Rock Island (No. 1) and Colchester (No. 2) coals.

Coal mining has long been one of the minor industries of western Illinois, but at no time has it been the chief industry. Nor, indeed, has the production of coal from this district ever been a large percentage of the total for the State, as indicated in Table 1. Nevertheless, the production in certain parts of the district has been noteworthy at times, and at present as in the past is not an unimportant factor in supplying local needs.

Table 1.—*Relative importance of District III in Illinois coal production*

Year	Production		Percentage of total for State
	District III *Tons*	State *Tons*	
1870	524,832	2,624,103	20.
1880	528,000	2,937,776	18.
1890	494,007	15,274,727	3.24
1900	741,311	25,153,929	2.94
1910	480,573	48,717,583	0.98
1920	435,436	73,920,653	0.59

ACKNOWLEDGMENTS

In presenting this compilation of available data, the writer is glad to acknowledge his indebtedness to many citizens of the western counties of the State. Landowners, drillers, and the men of the coal industry have furnished much of the information for this report, and their courteous cooperation in the work of the Survey is greatly appreciated.

Free use has been made of the early reports on the western part of the State by Worthen and of the Cooperative Mining Investigations bulletins, as well as of the published and unpublished data gathered by various members of the Survey. The miscellaneous notes of G. H. Cady, J. A. Udden, K. D. White, and others have been of especial assistance. For statistics of production and data on early mining, the annual reports of the Department of Mines and Minerals have been most valuable.

In the field work the writer has enjoyed the competent assistance of Messrs. W. F. Netzeband, John S. Ivy, and Paul T. Post. Mr. Post has also aided in the preparation of maps and diagrams for publication. In addition, the writer had the distinct advantage of cooperation with Mr. D. M. Collingwood, formerly of the Survey staff, to whose detailed structural studies in Greene, Jersey, and Madison counties reference is made in the text of this report.

TOPOGRAPHY

The area lies along the west margin of the State, and is, in large part, level prairie land. Sharp incision by streams in some parts of the area has resulted in considerable roughness and marked relief. This is particularly true in the southwestern portion, including parts of Adams, Schuyler, Brown, and Pike counties.

The elevations range from below 500 feet in southern Calhoun and western Fulton counties to over 800 feet in northeastern Mercer County. In general, the surface rises to elevations above 800 feet in both northern and southern parts, with low areas along prominent drainage lines throughout the district. The Mississippi and Illinois control the drainage of the area. In the north, the major tributaries are Rock River, Edwards River, and Henderson Creek; in the central part, Spoon River and Crooked Creek, and in the southern part McGees, Apple, Macoupin, and Piasa creeks.

The topographic character of the area is of importance in considering the availability of the coal. Deep incision by streams lowers the drainage lines below the coal beds in places, making possible exploitation of the beds by drifts or slopes, where otherwise shafts would be required.

The district is well supplied with railways, but these are not of importance in the exploitation of coal in this area because under present conditions, very little coal is shipped by rail.

STRATIGRAPHY

Pre-Pennsylvanian Formations

Because of the overlap relation of the Pennsylvanian to earlier formations, the rocks beneath the Pennsylvanian are not of the same age over all parts of the district. In the northeastern part of the district in Henry County, Niagaran limestone of Silurian age underlies the Pennsylvanian at shallow depth, while a few miles farther west it is replaced by the younger Devonian beds. Similarly, in central Mercer County, the Devonian base gives place to the still younger Mississippian rocks which appear to underlie the Pennsylvanian uniformly throughout the rest of the district, even in the structurally deformed area of southern Calhoun County. Sufficient drilling has not been done to demonstrate the precise position of the boundaries of these three systems of rocks, although there is some reason for believing that the Devonian rocks underlie the Pennsylvanian in most of Henry County, while the Mississippian beds form the base throughout most of Mercer County.

Although the character and age of the underlying rocks are of relatively small importance in the development of the coal resources of this district, the character of the surface on which the Pennsylvanian beds were deposited is of considerable importance. It is obvious that the determination of the nature of this surface is closely bound up with the identification of the base of the Pennsylvanian. Because information regarding the beds of the lower Pennsylvanian is derived entirely from records of drilling, it is practically impossible to use the ordinary criteria, fossils and structural relations, to separate the Pennsylvanian from the Mississippian strata. In drilling, it is customary to rely on the identification of one of the two or three readily recognizable strata in the lower formation. Thus, for instance, in Mercer County the base of the Pennsylvanian is placed at the top of the first prominent limestone penetrated, although it is obvious that some of the overlying clastic beds with thin intercalated limestones may belong to the Mississippian and yet on this basis be classed as Pennsylvanian.

Another illustration of the difficulty encountered in fixing the base of the Pennsylvanian formations is found in western Henry County, where the uppermost Devonian includes 100 feet or more of black shale with thin limestone or sandstone above and below it, and where furthermore, the overlying Pennsylvanian in many places is known to include black shale of considerable thickness. In drilling, the top of the Devonian is commonly placed at the top of the thick Devonian limestone. Thus, one record in northwestern Henry County records Pennsylvanian to a depth of more than 600 feet, including coal at depths of 99, 238, 311, 354, 479, 522, and 584 feet. Examination of this unique record shows that below the uppermost coal at 99 feet are a few feet of sandstone, underlain by more than 100 feet of blue shale, which is in turn underlain by 20 feet of limestone. Nowhere else in this region is such a sequence recorded in the Pennsylvanian system, whereas in an adjacent area to the west may be found comparable thicknesses of shale and limestone belonging to the upper Devonian. A correlation of this part of the record as the Devonian of western Rock Island County is therefore suggested, and on this basis it is assumed that exceptionally carbonaceous shales were reported as coal at the lower horizons.

Less conspicuous and less readily explained discrepancies regarding the base of the Pennsylvanian are abundant in records of deeper drilling throughout the district, and have caused considerable difficulty in determining the base of the Pennsylvanian. It should be understood therefore that all statements in this report regarding thicknesses of the whole Pennsylvanian, or of the basal member, and regarding the character of the pre-Pennsylvanian surface are based on a somewhat arbitrary identification of beds which are not easily recognized either in drill records or from samples of drill cuttings.

The surface of pre-Pennsylvanian rocks appears to have been subjected to erosive processes for a time sufficient to permit the development of a fairly even surface throughout the district. This surface is modified by local upwarpings, as in the Colmar region, McDonough County, and is also in places incised sufficiently to give rather marked roughness, although no great relief. It is impossible at the present time to draw even approximate contours on this whole surface, but its character for smaller areas will be noted in the county reports, where data permit.

Pennsylvanian System

GENERAL RELATIONS

Rocks of Pennsylvanian age underlie the drift throughout the area of District III, except for small linear tracts along Illinois River, Crooked Creek, and McGees Creek, where deep erosion has removed them. The area arbitrarily placed in District III does not comprise a geologic unit, as the beds in this District constitute a fringe on the main coal field of the State. Because of this relationship, the beds have certain lithologic characteristics which serve to contrast them with those of the important coal beds of Districts IV and VII on the east.

In general, the Pennsylvanian beds range in thickness from a feather edge on the west to more than 250 feet on the east margin, beyond which Rushville (No. 5) and Belleville (No. 6) coals appear. Theoretically at least, the coals in District III extend beyond the limit set for District III, but lie at considerable depths below the surface. Insofar as this actually occurs, District III and the districts to the east coincide.

Structurally, the Pennsylvanian beds are essentially flat, having a regional dip to the east and south toward the center of the main coal basin, which lies in the southeastern part of the State. This gentle inclination is interrupted and modified by minor warps and folds visible in outcrops and mines in most parts of the district.

Over most of the area the bed rock is concealed by a mantle of drift ranging in thickness to a known maximum of 233 feet, so that the determination of stratigraphic relations, structure, and coal resources for the District is based primarily on mine examination and scattered drill holes.

The Pennsylvanian series in the Illinois basin is subdivided into three formations, which from the base upward are called the Pottsville, Carbondale and McLeansboro. Recognition of these formations is by means of certain fossils, which usually appear in the roof shales of Colchester (No. 2) coal and in the cap limestone of Belleville (No. 6) coal. The Carbondale, or middle formation, includes Colchester coal at the base and Belleville at the top. All beds above Belleville coal belong in the McLeansboro group, and all below Colchester coal belong in the Pottsville. Inasmuch as by definition District III includes the area in which Rock Island and Colchester coals are the principal coals, this report is concerned with rocks classed as Pottsville and lower Carbondale, the eastern margin of District III being placed just west of the outcrop of Springfield (No. 5) coal. In places this boundary can be accurately mapped, but elsewhere, due to the heavy cover of drift, it can only be approximated and changes will doubtless be made on the basis of future drilling.

CORRELATION

As stated in the preceding paragraphs, the correlation of the beds within the Pennsylvanian depends upon the presence and recognition of Colchester and Belleville coals. It is clear that in the absence of these key horizons or in the failure of recognition of them, there is ample opportunity for miscorrelation.

It seems well at this point to introduce some statements regarding the status of correlation in this part of the Illinois field so that the importance of critical data in stratigraphic work may be clearly indicated.

The Pottsville formation includes the basal beds of the Pennsylvanian up to the bottom of Colchester coal.[1] Inasmuch as this coal bed has only a limited distribution in District III there are comparatively large areas where the top of the Pottsville formation can not be recognized. Furthermore, since the area under discussion lies at the margin of the Illinois coal field, the beds exposed, whether of early or late Pennsylvanian age, are mainly sandstone and sandy shale with little or no coal, the whole group being composed of notably lenticular members without good horizon markers. It is clear, therefore, that in the absence of the key bed, Colchester coal, there may have been included within the beds classed as Pottsville an indefinite thickness of strata which belong to younger formations. In correlating a given coal which lies in this marginal area, it is equally clear that without the key stratum, identification must be made arbitrarily, and should be held subject to later stratigraphic studies. Because of the wide variation in the roof material over the coals of this district, they have been correlated mainly on the basis of thickness, the thickest coal of any section having been considered the main coal of that general region. In view of the lenticular form of all of these beds, it is clear that errors may have been made.

In considering the beds classed as Carbondale, precisely the same factors of error must be considered. Hence it is fair to recognize the possibility or probability that the clastic strata of this age closely resemble those of the preceding (Pottsville) time and have been confused with them. Similarly, some of the beds classed as Carbondale belong in all probability to the following stage, the McLeansboro.

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[1] DeWolf, F. W., Year Book for 1909, Ill. State Geol. Survey Bull. 16, p. 179, 1910. (Although there has been some tendency to include the floor clay of the Colchester No. 2 coal with the Carbondale, the present practice of the Survey is to conform to the original definition and make the break at the precise base of the coal bed.)

It must be recognized, therefore, that any statement made in this report is based on the present accepted correlation, which may be in error to an unknown degree. So far as possible, repetition of this problematical error will be eliminated by the substitution of locality names of certain beds for the more generally used names and numbers. For example, the coal usually classed as the Pottsville (No. 1) coal of the northwestern part of the State will here be called the Rock Island coal. Similarly, the term Rushville coal will be used instead of the more common Springfield (No. 5) coal, thus avoiding the implication that this is identical with the main coal of the Springfield-Peoria field.

Recent work in the northwestern part of the State has suggested the probability that some of the thick sandstones in that area which have been classed as Pottsville should be placed in the McLeansboro formation[2].

To what extent the massive sandstones which characterize the basal Pennsylvanian along the west margin of the field may occupy the same or similar position in the stratigraphic column can be determined only on the basis of future detailed studies.

POTTSVILLE FORMATION

The beds classed as Pottsville are mainly sandstones and sandy shales, frequently conglomeratic in the lower part. The upper portion in places shows a massive phase which may be widespread. Thin, and in most places lenticular, beds of limestone appear (fig. 2), but rarely occur in a section sufficiently large to justify an opinion as to their stratigraphic position.

The coal beds are likewise lenticular, and though locally reaching a thickness of nearly 8 feet, the thicker parts are confined to small areas. In parts of the district, the workable coal lies in elongate basins roughly parallel with the margin of the field. In most parts of the district there is but one coal worked, although one or more thin coal beds are present. Locally these may be thick enough to warrant exploitation.

CARBONDALE FORMATION

Those beds lying above the Pottsville and below the McLeansboro formations are included in the Carbondale which has at its base the Colchester coal and at its top the Belleville coal.

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[2] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Ill. State Geol. Survey Bull. 38, p. 161, 1921.

The beds of the Carbondale are predominantly clastic, mainly shale, although including minor thicknesses of sandstone (fig. 3) and few thin limestones. In thickness, the series ranges from a few feet in the western part of the district to about 175 feet at the east where the protecting cap limestone at the base of the McLeansboro appears. This variation is probably due to two factors: 1) differences in original thickness, and (2) subsequent erosion of beds along the western margin.

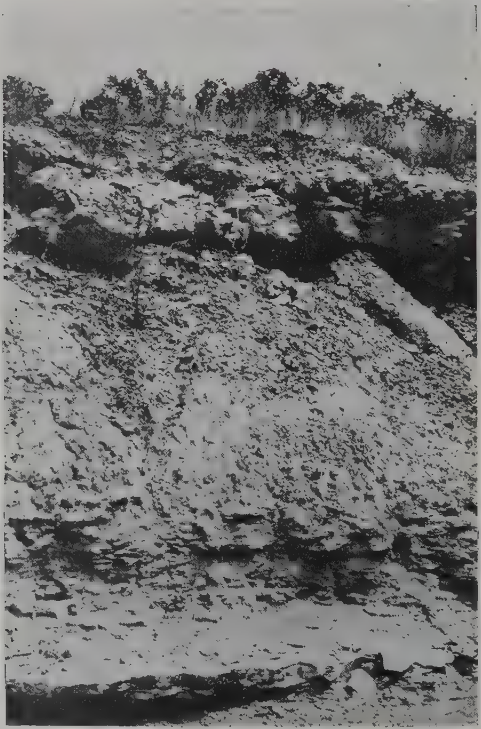

FIG. 2. Section of Pottsville beds including thinly bedded sandstone at base, overlain by shale locally carbonaceous, topped by nodular limestone which serves locally as a key stratum in Brown County.

The coal beds of this formation, although showing a somewhat irregular distribution, are much more regular in their development than are the coal beds of the Pottsville. Thus, although they are present over larger areas without break, they do not show the exceptional thickness which is exhibited locally by the Rock Island or Greenfield beds. The Colchester coal is usually about 24 to 30 inches thick and is noted for its uniformity over a given area. The Rushville coal is also rather uniform in thickness, ranging from 4 to 5½ feet where worked.

The Golden Eagle coal, isolated from the rest of the district by subsequent erosion of the connecting strata, has commonly been included with the beds of the Carbondale, sometimes as Colchester (No. 2) coal and frequently as Rushville (No. 5) coal.

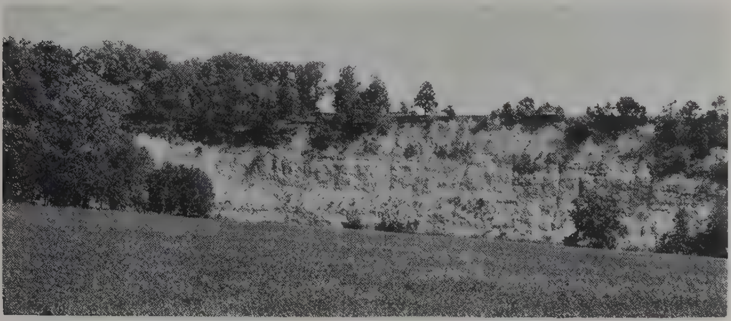

Fig. 3. Typical section of Carbondale strata in Adams County. Below the 15 feet of till lies 3 feet of sandstone which grades down in 40 feet to a non-gritty shale comprising the basal 20 feet.

MCLEANSBORO FORMATION

Although as defined originally the area included in District III did not include any beds classed as McLeansboro, later work by members of the Survey has served to show that in parts of the district there are strata which lie distinctly above what appears to be the Belleville coal, the top of the Carbondale formation. It is necessary, therefore, to indicate the area so classed and note briefly the character of the beds of this formation.

The McLeansboro formation comprises more evenly developed strata than characterize the Carbondale (fig. 4). Except at the west margin, sandstones are relatively few, shales are thick, but in places enclose marine limestones which, although thin, are persistent and wide-spread. The coal beds, on the other hand, are less common than in the lower formations, and with a few possible exceptions are of secondary commercial importance because of their thinness.

The area underlain by these beds is not yet clearly defined. They have been recognized, however, in western Rock Island, central Mercer, and northeastern Adams counties, and doubtfully in central Morgan and southern Calhoun counties.

Stratigraphically this formation is of importance since it includes certain marine strata which can be recognized readily. Among these are the cap limestone, and the red Rallsford shales over the Belleville coal, and in the east central part of the district the Lonsdale limestone. In the southern part of the district are one or more limestones which can be traced for considerable distances. The most important of these are the Piasa limestone, named from Piasa Creek on which it is most excellently exposed, and the Golden Eagle limestone, well known in Calhoun County. These beds are of considerable value in stratigraphic work, since they constitute horizon markers which can be positively identified over relatively large distances or areas.

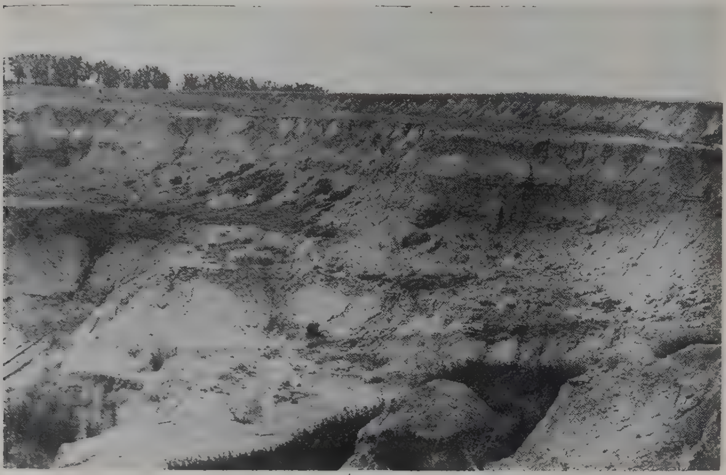

Fig. 4. Typical section of McLeansboro strata in Mercer County. Below 20 feet of drift, partly removed at right, lie 5 feet of shaly sandstone and 30 feet of clean shale with a thin carbonaceous zone at the base. Each bed shows little lateral variation.

STRUCTURE

Relation to General Structure of Illinois

Lying at the edge of the main Illinois coal basin, the Pennsylvanian beds of District III show a slight regional dip toward the central part of the major depression. This is barely perceptible locally but can be measured usually across a distance of several miles.

There is no other general or major structure which affects any large portion of the district, and the regional inclination is of importance only in stratigraphic studies, since the amount of dip is too small to be a factor in mining problems.

MINOR STRUCTURES

Minor structures are abundant. These include small faults, low folds, and local warps of the strata which modify and conceal the major structure locally and are of considerable importance in mining. Plans for haulage ways, drainage lines and other general features of a mine layout can be made to take advantage of these natural conditions, which if disregarded, may be a source of much trouble, danger and expense.

Determination of structure depends upon the identification of some one or more key beds occurring in a region. Since there is no one bed or group of beds distributed generally over the area included in District III it is impossible, with present data, to outline the structure as a whole. In several separate areas, however, one or more key beds are identifiable, and the major features of local structures have previously been worked out in connection with detailed quadrangle surveys. These studies have been restricted to the middle portion of the district, from southern Warren County to northern Schuyler County.

In the main, these structures have been determined with reference to the Colchester coal, the position of which has been indicated by a series of contour maps published for each area separately[3].

Structural studies on both Pennsylvanian and Mississippian strata, involving the relations of the two systems, have been made in Greene, Jersey, Madison and adjoining counties in connection with oil investigations made by the Survey. The results of this work, now being prepared for publication, are not available for this report, and the reader is referred to the forthcoming bulletin for details of structure in that portion of District III.

Details of the other structures, where related to the matter of coal resources, will be noted in the several county reports.

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[3] Hinds, Henry, U. S. Geol. Survey Atlas, Colchester-Macomb folio (No. 208), 1919.

Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Ill. State Geol. Survey Bull. 38, p. 209, 1921.

Savage, T. E., and Nebel, M. L., Geology and mineral resources of the La-Harpe and Good Hope quadrangles: Ill. State Geol. Survey Bull. 43, p. 9, 1921.

CHEMICAL CHARACTER OF THE COAL OF DISTRICT III

Detailed reports[4] on the chemical character of Illinois coals have been published in Bulletins 3 and 27A of this series, and in Bulletin 29 of the State Geological Survey so that a discussion of the quality of the coals in this district is not necessary. However, for convenience, tables giving analyses for individual mines (Table 2) and average analyses for mines and counties in District III (Table 3) are here given.

A very brief statement of the meaning of each of the several columns, which give the results of analyses in Tables 1 and 2, will doubtless be of service in rendering these results more intelligible, and therefore of greater usefulness to the average reader unfamiliar with the technology of coal.

In the "Proximate Analysis" of coal no attempt is made to determine the chemical elements which make it up, but the constituents are resolved into four groups known as volatile matter, fixed carbon, ash, and moisture. The relative percentages of these are given in Table 2 as are also other features such as the heat value, amount of sulphur, and carbon dioxide.

A recalculation of the results of each analysis is given on a second line to show the relative percentages of the constituents on a "dry" basis. Thus by the elimination of the 11.38 per cent moisture by calculation in analysis No. 12469, the 38.66 per cent of volatile matter becomes 43.62 per cent in the "dry coal."

The moisture content of coal though unavoidable is detrimental. Not only does the water displace its own weight of combustible matter, but in addition it absorbs heat when the coal is burned. Obviously, a coal of low moisture content is desirable.

The ash in coal (chiefly compounds of silica, alumina, lime, and iron, together with smaller quantities of magnesia, titanium, and alkali compounds) is another harmful constituent. Not only does it displace its own weight of heat-forming compounds, and decrease the efficiency of combustion just as does the moisture, but in addition any increase in ash percentage means a corresponding increase in the cost of handling the coal, by making both freight costs and costs of disposition of the refuse greater. Furthermore, certain types of ash contain such high percentages of iron and alumina that they fuse easily and cause clinkering trouble in furnaces.

The "volatile matter" and "fixed carbon" columns give the relative amounts of gaseous and solid combustible matter. They are the heat-producing constituents. For domestic use a low-volatile coal is to be preferred because the ordinary domestic stoves and furnaces are capable

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[4] Parr, S. W., A chemical study of Illinois coals: Ill. Coal Mining Investigations Bull. 3, 1916. (Edition exhausted. Analyses reprinted in Ill. Mining Investigations Bull. 27A).

Parr, S. W., Purchase and sale of Illinois coal under specifications: Ill. State Geological Survey Bull. 29, 1914. (Edition exhausted. Analyses reprinted in Ill. Coal Mining Investigations Bull. 27A).

Hawley, G. W., Analyses of Illinois coals: Ill. Coal Mining Investigations Bull. 27A, 1923.

TABLE 2.—*Analyses of coal samples from mines in District III*

Laboratory number	Index number	Date	County	Coal bed	Proximate analysis of coal. 1st: "As received," with total moisture. 2nd: "Dry" or moisture free.							
					Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	Unit coal
12469	105	3-21	Fulton........	1	11.38	38.66	39.51	10.45	4.52	.87	11436	....
					Dry	43.62	44.58	11.80	5.10	.98	12905	14979
12470	105	3-21	Fulton........	1	11.42	38.17	40.07	10.34	4.76	.45	11409	....
					Dry	43.09	45.24	11.67	5.37	.51	12880	14934
12471	105	3-21	Fulton........	1	10.84	38.42	40.91	9.83	5.61	.54	11554	....
					Dry	43.09	45.88	11.03	6.29	.61	12959	14939
5338	19	8-12	Mercer........	1	13.23	40.29	37.20	9.28	4.37	.41	11104	....
					Dry	46.43	42.88	10.69	5.04	.47	12797	14641
5339	19	8-12	Mercer........	1	15.24	37.66	35.73	11.37	4.80	1.47	10353	....
					Dry	44.44	42.15	13.41	5.66	1.73	12214	14478
5340	19	8-12	Mercer........	1	15.15	39.06	38.48	7.31	3.30	.17	11252	....
					Dry	44.44	42.15	14.41	5.66	1.73	12214	14478
5363	19	8-12	Mercer........	1	14.97	38.27	37.07	9.69	3.75	.33	9637	....
					Dry	46.03	45.36	8.61	3.89	.19	13260	14760
5364	19	8-12	Mercer........	1	14.46	40.42	35.33	9.79	4.23	.69	10780	....
					Dry	44.99	43.61	11.40	4.95	.43	12749	14712
5365	19	8-12	Mercer........	1	14.07	39.95	34.01	11.97	4.55	.78	10525	....
					Dry	47.24	41.32	11.44	4.94	.59	12603	14551
5359	18	8-12	Mercer........	1	14.58	39.49	36.82	9.11	5.60	.15	10894	....
					Dry	46.49	39.59	13.92	5.29	.91	12247	14604
5360	18	8-12	Mercer........	1	15.07	38.14	37.44	9.35	4.85	.34	10790	....
					Dry	46.23	43.09	10.68	6.56	.18	12754	14642
5361	18	8-12	Mercer........	1	14.10	39.60	36.73	9.57	3.92	.23	10956	....
					Dry	44.91	44.01	11.02	5.71	.38	12705	14618
5371	17	8-12	Mercer........	1	17.75	39.50	34.61	8.14	5.53	.86	10435	....
					Dry	48.03	42.08	9.89	6.72	1.05	12687	14373
5372	17	8-12	Mercer........	1	17.50	38.78	33.66	10.06	4.51	.29	10238	....
					Dry	47.00	40.80	12.20	5.46	.35	12409	14372
2641	230	7-09	Calhoun	2	10.62	38.13	39.65	11.60	4.96	......	11224	....
					Dry	42.67	44.36	12.97	5.55	......	12557	14806
5232	22	7-12	McDonough...	2	19.35	31.70	40.61	8.34	2.31	.37	10392	....
					Dry	39.35	50.40	10.35	2.87	.46	12898	14605
5233	22	7-12	McDonough...	2	16.46	33.94	42.46	7.14	1.71	.11	11064	....
					Dry	40.63	50.83	8.54	2.04	.14	13246	14660
5234	22	7-12	McDonough...	2	16.39	34.26	41.36	7.99	2.04	.33	10977	....
					Dry	40.97	49.47	9.56	2.44	.40	13130	14725
9728	213	11-16	McDonough...	2	14.89	35.48	40.75	8.88	3.78	......	10969	....
					Dry	41.68	47.88	10.44	4.43	......	12887	14678
9729	213	11-16	McDonough...	2	16.83	34.68	39.79	8.70	3.94	......	10628	....
					Dry	41.71	47.83	10.46	4.74	......	12778	14565
9709	214	11-16	Schuyler	2	12.34	38.11	42.29	7.26	4.32	......	11841	....
					Dry	43.48	48.24	8.28	4.92	......	13507	15011
9708	214	11-16	Schuyler	2	12.73	37.56	41.88	7.83	4.77	......	11621	....
					Dry	43.04	47.99	8.97	5.46	......	13316	14924

TABLE 3.—*Average analyses and heat values for separate mines and for counties in District III*

DISTRICT NO. 3—FULTON CO., NO. 1 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
105	11.21	38.41	40.16	10.20	4.96	.62	11466	....
	Dry	43.26	45.23	11.50	5.58	.70	12914	14950

DISTRICT NO. 3—MERCER CO., NO. 1 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
17	17.63	39.13	34.13	9.11	5.02	.70	10336	....
	Dry	47.51	41.44	11.05	6.09	.85	12548	14373
18	14.58	39.07	37.00	9.35	4.79	.21	10880	....
	Dry	45.74	43.31	10.95	5.61	.25	12737	14640
19	14.52	39.26	36.32	9.90	4.24	.68	10809	....
	Dry	45.93	42.49	11.58	4.96	.80	12645	14624
Average	15.58	39.17	35.80	9.45	4.69	.53	10673	....
	Dry	46.40	42.41	11.19	5.55	.63	12643	14546

DISTRICT NO. 3—McDONOUGH CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
22	17.40	33.30	41.47	7.82	2.02	.27	10811	....
	Dry	40.31	50.23	9.48	2.45	.33	13091	14663
213	15.86	35.08	40.27	8.79	3.86	....	10798	....
	Dry	41.69	47.85	10.45	4.58	....	12832	14621
Average	16.63	34.19	40.37	8.31	2.94	....	10804	....
	Dry	41.00	49.04	9.96	3.51	....	12961	14642

DISTRICT NO. 3—SCHUYLER CO., NO. 2 COAL

Index number	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	CO_2	B. t. u.	"Unit coal"
214	14.53	37.83	42.08	7.54	4.54	....	11731	....
	Dry	43.26	48.11	8.62	5.19	....	13411	14967

of utilizing only a small proportion of the volatile matter. However, modern steam-generating appliances such as are used industrially are so constructed as to take care of the gases satisfactorily and either low- or high-volatile coal can be used with equal efficiency.

Sulphur is present generally in the form of pyrite (iron sulphide). It is especially deleterious in the manufacture of coke and gas, and if associated with an ash of high lime and iron content it may help to cause clinkering. Otherwise it is not particularly harmful, for as a rule it displaces a negligible amount of combustible material, and has some virtue in that it does not absorb heat as do water and ash, but produces about a third as much heat as does carbon.

The "B.t.u." column gives the calorific (heat) value of the coal in British thermal units per pound of coal. This value indicates the heating power of the coal and is therefore important as a means of comparison of different coals. In the calculation of this figure, account is taken of the ash and moisture present, as well as of the combustible matter.

"Unit coal," on the contrary, takes account only of the pure coal substance, free from ash, moisture, sulphur, or other impurities. Since the "pure coal" is essentially the same for any single mine from year to year, the "unit-coal" figure will remain practically unchanged; the "B.t.u." figure, however, will vary in proportion to the variations from place to place in the mine in the amount of ash, sulphur, and moisture present, and therefore for the average practical user, up-to-date B.t.u. values will afford a more satisfactory means of comparison of the coals than will the "unit-coal" values, useful though they may be for certain purposes.

PART II—COUNTY REPORTS

ADAMS COUNTY

General Statement

Adams County lies in the extreme west margin of the Pennsylvanian basin, and has but a thin veneer of "Coal Measures" over the Mississippian strata (Pl. I B). The Pennsylvanian is found mainly in Ranges 5 and 6 W. although apparently disconnected patches are found farther west as at Mendon, T. 1 N., R. 8 W. The system is thin, the coal of irregular development, and no extensive operations have been reported.

Production and Mines

The reports of the Department of Mines and Minerals for the last few years have shown no mines operating in Adams County, either local or shipping. Little or no production is therefore to be listed for this county.

Area underlain by workable coal	369 sq. mi.
Average thickness	24 inches
Amount available originally	838,720,000 tons
Production, year ending June 30, 1923	none
Average annual production, 1919-1923	20 tons
Total production recorded	464 tons

Stratigraphy

PLEISTOCENE SYSTEM

The Pleistocene beds are not as thick in the eastern portion of Adams County as they are farther north. Records of borings show thicknesses ranging from 10 to 85 feet. These materials include the usual loess at the top, which ranges from 5 to 10 feet in thickness, with yellow or blue drift clays beneath. The differences in thickness of the drift appear to be referable to the unevenness of the earlier rock surface. The thickness of the loess covering is, of course, greater to the west, reaching a maximum of 40 feet on the bluffs overlooking Mississippi River.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds do not outcrop prominently, although along certain of the streams exposures are fairly abundant. Even though some portions of Adams County have been drilled rather extensively in oil tests, the records kept for the Pennsylvanian portion of the section are unsatisfactory, and therefore little information is to be gained from most of the records of the borings. Such information as is available shows the thickness of the Pennsylvanian to range from a few feet to more than 140 feet. Worthen placed the maximum at 120 feet for the whole county. Difficulty of recognizing the base of the Pennsylvanian where it is in contact with some of the shales of the Upper Mississippian, makes it impossible to fix definitely the thickness of the "Coal Measures". The figures given above may therefore be increased by as much as 100 feet. The following generalized section is fairly uniform over the eastern part of the county:

Generalized Pennsylvanian section for eastern Adams County

Description of strata	Thickness	
	Ft.	*In.*
Limestone and underclay	4	..
Shale, blue	55	..
Sandstone, shaly and calcareous	11	..
Limestone, very cherty	3	..
Shale, blue, sandy at top	20	..
Limestone (?) discontinuous	1	..
Shale, black fissile, "slate"	2	..
Coal, Colchester (No. 2)	2	..
Underclay and shale	12	..
Limestone, nodular	1	6
Shale; sandstone series with several discontinuous conglomeratic zones	21	..
Shale, blue	3	..
Limestone, black	1	..
Sandstone, platy	7	..
Sandstone-shale series	..	..
Basal part white sandstone	8	..

Within the section the more prominent beds include a limestone 25 to 50 feet above the top of Colchester (No. 2) coal, the coal itself, the nodular limestone 10 to 15 feet below and a black limestone 25 to 35 feet below the Colchester coal.

Worthen records the presence of three coal beds in the county of which the middle or Colchester bed is by far the most widespread. Examination of the area about sec. 17, T. 1 N., R. 6 W., in which Worthen's No. 3 was reported, has not revealed such coal, and it is possible that a change in the roof material over the Colchester coal in that vicinity led him to mistake the bed for one overlying the Colchester.

Coal No. 1, according to Worthen, included those patches of coal occurring along the west margin of the Pennsylvanian area, and which were unrelated to the main field. Differences in roof material, as well as in the character of the bed itself, led him to consider these as the outliers of a Pottsville coal. This may be their true relation, although it is possible that they may be either Colchester or a higher bed.

The Colchester coal is fairly uniform in its development within the area mapped in the eastern part of the county. It has been removed by erosion along major streams in the southeast part of the county, as along McGees Creek in the vicinity of Haselwood, and along the creek east of Richfield. The upland area is apparently uniformly underlain by this coal.

STRUCTURE

The structure of the Pennsylvanian beds can be determined only on the basis of the attitude of the Colchester coal, the attitude of which in turn depends on the identification of this bed throughout the area. It is believed that the section which includes the Colchester coal is readily identifiable, and that therefore the identification of this coal in outcrops and mines is probably correct. Its identification in well records is obviously less secure. On this basis, however, the altitude of the top of the Colchester coal ranges from about 600 to 680 feet. These altitudes vary within short distances, however, and if any general inclination is apparent, it is to the north and east at a very low angle. Earlier studies[5] in T. 1 N., R. 5 W. (Clayton Twp.) have suggested a doming of the Pennsylvanian in the east central part, but sufficient data are not at hand to show the relation of this to other minor structures.

COLCHESTER (No 2) COAL

The main area for Colchester coal is the eastern two ranges from the north county line to the vicinity of Richfield, except along McGees Creek where erosion has removed the Pennsylvanian strata. A typical section, including the coal, is as follows:

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[5] Currier, L. W., Geology of northeastern Adams County: Ill. State Geol. Survey Bull. 43, p. 308, 1922.

Typical Pennsylvanian section including Colchester coal in Adams County

Description of strata	Thickness Ft.	Thickness In.
Shale, light gray	1	..
Shale, light gray calcareous, with abundant Chonetes	1	..
Limestone, nodular, light gray fossiliferous	..	10
Shale, light to medium gray, calcareous, Chonetes abundant	1	3
Shale, medium to dark gray	..	3
Shale, black fissile "slate"	..	1
Coal, soft dull	1	4
Sand, argillaceous, light gray	5	..
Limestone, crystalline, Mississippian	..	..

The roof of this coal is commonly of gray shale, although it is locally replaced by a black "slate", as in the above section. The floor material is generally unconsolidated, mainly clay, which is locally sandy.

It does not appear probable from the general relations of the Pennsylvanian beds that the coal of this region will ever become commercially important.

MENDON COAL

There is a small area in the vicinity of Mendon, T. 1 N., R. 8 W., where coal has been stripped to a limited extent. The correlation of this bed is not possible on present data, but the isolated position of the bed with reference to the rest of the Pennsylvanian of the county suggests that it is to be classed with the marginal beds, although it may belong to the upper rather than the lower part of the Pennsylvanian system. The coal shows a maximum of nearly 5 feet, but probably averages about 48 inches. The area underlain by this bed is thought to be extremely small, but because of the favorable thickness and cover it is considered as a factor in the resources of the county. A section of this coal is given:

Pennsylvanian section including Mendon coal in Adams County

Description of strata	Thickness Ft.	Thickness In.
Coal, dull, weathered	..	8
Bone and sulphur	..	2
Coal, dull with bright bands, lenses of sulphur	..	12
Shale, parting, black locally sandy	..	2
Coal, dull, harder than above	..	28
Total		52

The roof is all drift where known, but is probably the usual shale or "slate" locally. The floor is a light gray clay in places, but is mainly sandstone. These features indicate that this bed was deposited near the margin of the area of coal formation, and bear out the suggestion that it is an original outlier of the main coal field.

BROWN COUNTY

GENERAL STATEMENT

Brown County lies near the west margin of the coal basin, and in its general geology closely resembles Schuyler County to the north—that is, the beds of the Pennsylvanian are thick at the east margin of the county, but thinner in the west, appearing to overlap the Mississippian limestones over most of the county. They have been eliminated entirely along McGees Creek in the southern part of the county, and along Crooked Creek in the northern part (Pl. I B).

PRODUCTION AND MINES

Very little mining has been done in the county, most of it in the vicinity of Damon, Mt. Sterling, and Ripley. The report of the Department of Mines and Minerals for 1923 lists but one mine, producing a total of 150 tons. The report for 1920 gave six local mines, producing a total of over 3,000 tons.

Area underlain by workable coal	182 sq. mi.
Average thickness	24 inches
Amount available originally	412,820,000 tons
Production, year ending June 30, 1923	150 tons
Average annual production, 1919-1923	4,668 tons
Total production recorded	26,489 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The Pleistocene is not exceptionally thick over the county, as it averages about 30 or 40 feet. Locally, on account of irregularities in the bed rock surface, it reaches a maximum of 120 feet. These beds are mainly drift, boulder clay, with some sand and gravel, capped in most places by the unconsolidated loess. Along McGees and Crooked creeks and Illinois River, the alluvium deposited by these streams reaches considerable thickness. One well near Crooked Creek records 210 feet of alluvium above the bed rock. The loess also is locally 100 feet thick, but is much thinner except near the Illinois bluffs.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds found in the county belong in two formations, the Pottsville and the Carbondale. The Pottsville formation relatively thin, ranging from 6 to 50 feet in thickness, comprises soft gray or white fire clay, sandstone, and locally a thin limestone. Rarely a thin carbonaceous bed appears. Near LaGrange, the following Pottsville section appears[6]:

Section measured near center sec. 29, T. 1 S., R. 1 W.

Description of strata	Thickness *Ft.*	*In.*
Shale and underclay of No. 2 coal	7	..
Limestone, white nodular (Key horizon No. 3)	5	..
Shale, gray	3	..
Shale, sandy	3	..
Clay shale, weathers out white	9	..
Coal	..	4
Sandstone, ferruginous	5	..
Shales, sandy and clay	9	..
Limestone (St. Louis)	12	6
Dolomite, sandy (Salem) (Key horizon No. 2)	20	6
	74	4

The Carbondale has a maximum thickness of about 130 feet and consists of shales, sandstone, thin limestones, and locally Rushville coal and more uniformly Colchester coal at the base. A typical section of the Carbondale for the northern part of the county, as given by Nebel[7] follows:

Generalized section of the Carbondale formation in the north half of Brown County

Description of strata	Thickness *Ft.*	*In.*
Shale	5	..
Limestone, white nodular (Key horizon No. 8)	2	6
Shale, gray	11	..
Limestone, gray, with Chonetes? and *Spirifer cameratus* (Key horizon No. 7)	1	..
Shale, gray	13	..
Limestone, white or light gray, heavy nodular (Key horizon No. 6)	5	..
Clay shale, soft, gray or blue	6	..
Sandstone and sandy shale	10	..
Shales, blue gray, sandy	59	..

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[6] Nebel, M. L., Brown County: Ill. State Geol. Survey Bull. 40, p. 30, 1919.

[7] Idem, p. 29.

Generalized section of the Carbondale formation in the north half of Brown County—Concluded

Description of strata	Thickness Ft.	Thickness In.
Limestone, shaly fossiliferous (Key horizon No. 5)	2	6
Clay shales, blue, sandy	20	6
Limestone, black, septarian	1	..
Shales, black, bituminous, thin-bedded (black slate)	3	..
No. 2 coal (Key horizon No. 4)	2	..
	141	6

STRUCTURE

The following quotation from an earlier report of the Survey presents all available information as to the structure of the Pennsylvanian strata in Brown County[8]:

DETAILED STRUCTURE

"The detailed structure was worked out by obtaining the elevation of seven key horizons. The most uniform and most reliable of all these horizons is No. 2 coal, and it was selected as the one most likely to show all details of structure. Its elevation above sea level was determined either by direct leveling or by computation from the elevations of the other key horizons, and a structure-contour map constructed by drawing lines through all points of equal elevation. The following structures were revealed:

"In general the coal dips to the east, but it has a rolling surface upon which are developed small domes, anticlines, terraces, and synclines. The maximum elevation attained is 653 feet in sec. 5, T. 3 S., R. 4 W. (Fairmount Twp.), just over the line in Pike County. The coal in the southwestern portion of Brown County is high, with a decline to the east of 123 feet to an elevation of 530 near Illinois River. In the northwestern portion of the county it is again high, rising to an elevation of 617 in sec. 29, T. 1 N., R. 4 W. (Pea Ridge Twp.), and decreasing to the east to an elevation of 516 in sec. 24, T. 1 N., R. 3 W. (Missouri Twp.). Outcrops are almost lacking in a broad belt across the central portion of the county so that it is impossible to predict the structure in that area.

"Covering most of T. 2 S., R. 3 W. (Elkhorn Twp.), and parts of adjoining townships is a broad terrace upon which lie three small domes. The terrace has an elevation of about 580 feet above sea level. A small dome covers most of sec. 1, T. 2 S., R. 4 W. (Buckhorn Twp.). At the apex of the dome in the NE. ¼ sec. 6, T. 2 S., R. 3 W. (Elkhorn Twp.), the coal has an elevation of 607 feet and is about 30 feet higher than to the north and east. To the south and west there is only a slight decline.

"In sec. 7, 8, 9, 17, and 18, T. 2 S., R. 3 W. (Elkhorn Twp.) is an irregular flat dome upon which the coal lies at an elevation of 600 feet or 30 feet higher than in the area to the north and east.

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[8] Nebel, M. L., Brown County: Ill. State Geol. Survey Bull. 40, p. 44-46, 1919.

"A broad terrace at an elevation of 580 feet covers most of the southern half of T. 2 S., R. 3 W. (Elkhorn Twp.), with a slight doming in secs. 13, 24, and 25. The apex lies at 596 feet in section 13. To the east the rocks dip off rapidly, so that the apex of the dome rises about 50 feet. To the west there is first a gentle dip, then the rocks rise into a sharp anticline.

"Extending almost due north in secs. 16, 17, 20, 21, 32, and 33, T. 2 S., R. 4 W. (Buckhorn Twp.), is a sharp anticlinal nose on which the coal lies 50 to 60 feet higher than to the north, east, and west. The shape of this structure on the south has not been determined, since field work extended only a short distance south of the county line. The highest known point is in the NW. ¼ sec. 5, T. 3 S., R. 4 W. (Fairmount Twp.), Pike County, where the coal lies 653 feet above sea level. To the west the coal dips steeply into a narrow syncline, while to the east it slopes gently toward the broad terrace in T. 2 S., R. 3 W. (Elkhorn Twp.). It is possible that additional data in Pike County will modify this structure, and that the coal may rise even higher to the south.

"In T. 1 S., R. 2 W. (Cooperstown Twp.), is an area of uplift, but outcrops are very few in this township, and it is impossible to outline the structure accurately. The data available suggest a broad dome with its apex in sections 27, 28, 32, 33, and 34, in which the coal lies 20 to 30 feet higher than in the area to the west, and 50 to 60 feet higher than in the area to the east. It slopes off gently to the north and south.

"In T. 1 N., R. 4 W. (Pea Ridge Twp.), is a dome with its apex lying in sections 20, 21, 28, and 29, at an elevation of 617 feet. It is 30 feet higher than to the east, south, and west. To the northeast it flattens out into a broad terrace, covering sections 2, 3, 9, 10, 15, and 16 at an elevation of 590 to 600 feet. In sections 13 and 14 of the same township is a slight dome arising about 20 feet above the surrounding territory, and sloping off into a low, narrow anticline to the northeast in secs. 5, 6, 7, and 8, T. 1 N., R. 3 W. (Missouri Twp.).

"A narrow strip across the northeast corner of the county, covering parts of Missouri and Ripley townships, was studied in 1914 by Morse and Rich.[1] The structural relations suggested by them have been slightly modified by new data, obtained in the course of the present work, but no important changes need be made. A dome exists in secs. 1, 2, 11, and 12, T. 1 N., R. 3 W. (Missouri Twp.), as indicated by their work, with a large syncline to the southeast. The broad Ripley dome in T. 1 N., R. 2 W. (Woodstock, Schuyler County, and Ripley, Brown County), is best interpreted as a terrace, since the new data indicates that the contour lines do not close around the south end.

"A small synclinal basin lies in secs. 8, 9, 16, and 17, T. 1 S., R. 3 W. (Mt. Sterling Twp.), completes the list of structures brought out by the contour map."

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[1] Morse, Wm. C., and Kay, Fred H., The area south of the Colmar oil field: Ill. State Geol. Survey Bull. 31, pp. 8-36, 1915.

Colchester (No. 2) Coal

The Colchester (No. 2) coal is present over a large area lying between the valleys of Crooked Creek and McGees Creek. Here it is uniformly about 2 feet thick, without partings and of good quality, as elsewhere in this part of the State. The roof is black shale except in the northern part of the county where from one to eight feet of gray shale come in between the black shale and the coal. The floor is gray clay, sandy in places, about three feet thick.

In the extreme eastern part of the county, near LaGrange, T. 2 S., R. 2 W., is a small area which is presumably underlain by Colchester coal of usual thickness. The coal and accompanying strata essentially duplicate those in the larger field to the west.

Between these two fields, an area comprising nearly one-third of the county, no workable coal has been reported.

Mount Sterling Coal

In the immediate vicinity of Mt. Sterling, sec. 8, T. 1 S., R. 3 W., a coal ranging from two to three feet in thickness was mined for a time. This lies above the Colchester coal, possibly at the same horizon as the Rushville coal of Schuyler County, and is therefore here called the Rushville coal.

This coal is recorded in but a few places and does not appear to be of importance in an estimate of the resources of the county. While it underlies an area that may be as large as three or four square miles, it is apparently too irregular in its thickness to be of any value for mining.

BUREAU COUNTY

General Statement

Only the western part of Bureau County is included in District III (Pl. IA). This area lies at the extreme north edge of the Illinois coal basin, the margin of the "Coal Measures" passing through T. 17 N., in ranges 6 and 7 E. The thickness and character of the Pennsylvanian beds suggest that they once extended farther north but have been partly eroded. The precise boundary of the rocks of this system is not known, but the workable coal extends little if any north of T. 16 N.

PRODUCTION AND MINES

While at no time an important item in the total production of the county, there has always been a small tonnage won from this district for local use. The abandoned mines near Sheffield were among the first ones opened in the county, but at present the operations are in the next township west. The 1923 report of the Department of Mines and Minerals lists 5 mines from this part of the county.

STRATIGRAPHY

PLEISTOCENE SYSTEM

Except along stream valleys, all bed rock is concealed by the surficial deposits. These comprise the usual glacial and recent materials, unconsolidated, and very irregular in extent. They range in thickness from less than 10 feet to more than 100 feet. West of Sheffield, in T. 16 N., R. 7 E., the loose material is thinner than to the south, but east of Sheffield the cover is thickest. The records across the line in Henry County showing more than 200 feet of drift suggest deep erosion of the Pennsylvanian beds. This may extend in to the area about Neponset, T. 15 N., R. 6 E., where there are no records of borings.

PENNSYLVANIAN SYSTEM

Outcrops of the Pennsylvanian rocks are rare and the lack of adequate drill records makes impossible more than generalized statements of the character of these beds. Typical sections are exposed along the creek east of Sheffield. Here the uppermost beds are sandstone, about 15 feet thick, underlain by about as much shale. Below these are two calcareous beds, the upper a massive argillaceous bed, the lower a limestone ranging from 1 to 2 feet thick. Still lower is a shale zone about 3 feet thick, in places sheeted and hard, but elsewhere soft. Under this variable cover is a coal of fairly uniform development, about 4 feet thick and having a light gray, sandy underclay.

The recorded logs for this area show similar successions of beds, mostly sandy shale or sandstone, with little coal and an occasional bed of limestone. As is to be expected in an area so near the margin of the Pennsylvanian coal basin, the rocks show considerable variation from place to place. The coal itself ranges from a few inches to five feet, but carries a shale parting near the middle in most places. Other clay partings occur locally near the bottom of the bed. In places the roof is black shale or soapstone, elsewhere sandstone, and less commonly the cap limestone comes down to the clod over the coal. The following log is typical of the beds in this region:

Typical log of Pennsylvanian strata in Bureau County

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Soil and clay	12	..	12	..
Sand	3	..	15	..
Sandstone, soft	3	..	18	..
Clay shale	7	..	25	..
Shale, light	11	4	36	4
Hard rock	..	8	37	..
Slate	1	..	38	..
Coal Sheffield (No. 6)	4	5	42	5
Light shale-lime nodules	31	3	73	8
Light sandy shale nodules	19	..	92	8
Shale, gray	27	..	119	8
Sandstone, shale	6	..	125	8
Shale, dark and gray	35	..	160	8
Shale, gray	46	..	206	8
Shale, light	4	..	210	8
Shale, gray	4	6	215	2
Shale, light	2	10	218	..
Fossil limestone	..	8	218	8
Slate	2	..	220	8
Shale, dark	5	6	226	2
Slate	2	8	228	10
Shale, light	6	..	234	10
Slate	..	10	235	8
Shale and sand, light	11	6	247	2

Few beds in the section can be recognized definitely. The series of five beds above the coal in the log belong clearly to the sequence which always accompanies this coal in Bureau and adjoining counties. The "hard rock" is the limestone which uniformly carries fossils, among which is usually the fusulina that has long been considered an index fossil for the Sheffield coal.

Other coals appear in the area in places, but are less frequently recorded than in the Sheffield area. At a depth of more than 150 feet there is in places a 3-foot bed which has been correlated with the "third vein" of the La Salle area. A 2-foot bed of coal has also been noted in some parts of this region lying 25 to 40 feet above the Sheffield coal.

STRUCTURE

So far as the data at hand indicate, the Pennsylvanian beds of this part of Bureau County are essentially flat-lying. Local arching of a few feet is noted in all mines, but no general deformation is recognizable. In most mines, also, are small fractures and slips of the rocks enclosing the coal, too small to be considered important structural features.

SHEFFIELD COAL

The most important coal of this portion of Bureau County is the 4-foot bed which is found at shallow depths near Sheffield. It was deposited irregularly over the south two-thirds of T. 16 N., in ranges 6 and 7 E., so that while locally it is of workable thickness, there are considerable areas in which it is too thin to be of value. There are no data on this coal for T. 15 N., but from its presence in the adjacent portion of Henry County it seems probable that it will be found here also. On this assumption, this part of the county should be included within the area mapped as containing workable coal belonging to this seam.

The coal ranges in thickness from a few inches to a maximum of 5 feet. In most mines it reaches maximum thickness, but the average is about 53 inches.

The Sheffield coal is somewhat variable in quality, but is in general a better coal than others in this region. It is hard, mostly bright, with sub-conchoidal fracture. It is plainly laminated, with mother of coal partings. It contains some calcite and gypsum as well as pyrite as impurities. The pyrite is much more common in the zones of fracture which are common in parts of this bed. Elsewhere it is of little consequence. A shale parting from ¼ inch to 2 inches thick commonly separates the coal into two benches. This is not everywhere present, but is commonly considered diagnostic of this bed.

A cap limestone is usually present over the coal, but separated from it by a few inches to several feet of shale. The shale is light gray to black and may be soft and loose or may be sheeted, hard and "frozen" to the coal. In the latter case it has to be drawn with the coal. Locally the shale top is gritty enough to be classed as sandstone, but this phase commonly grades to the true shale in short distances. In places, however, as near Sheffield, the beds normally over the coal have been eroded, and replaced by a later sandstone. Locally such sandstones "cut out" the coal.

The floor is hard underclay, light in color, and containing at or near its base calcareous matter either as nodules or as a distinct bed of lenticular shape.

The following notes from one of the mines in this region show typical conditions for the Sheffield coal:

Shaft: 51 feet deep; surficial material 9 feet.

Roof: Limestone, with slate up to 54 inches beneath.

Coal: Maximum thickness 62, minimum 48, average 58 inches.

Floor: Shale, light gray, dry; does not heave.

Notes: The coal lies in an east-west trending basin; it is affected by a number of "horsebacks", which occur in a zone near the shaft. Pyrite is common in Bureau County and near the horsebacks, but the coal is unusually clean elsewhere.

OTHER COAL BEDS

Over part of the area, as near Buda, T. 16 N., R. 7 E., a coal averaging 24 inches in thickness is reported from 25 to 40 feet over the Sheffield coal. It appears to have an extremely irregular disposition and to be of inferior grade. It is therefore not considered in the estimate of coal resources for the county. Another bed, lying between 100 and 200 feet below the Sheffield coal, is recorded near Sheffield. This is probably the coal mined near Tiskilwa and recorded in a log from Annewan in Henry County. It is tentatively correlated with the "Third Vein" of LaSalle County. No data at hand indicate this as an important bed and it is not considered in the estimate of the county's resources.

CALHOUN COUNTY

GENERAL STATEMENT

Calhoun County lies in the extreme southwest corner of District III, and is separated from the main coal field by both Illinois River and a structural deformation which brings the Mississippian rocks to the surface on the northeast (Pl. I B). As a result, only the extreme southern part of the county is underlain by "Coal Measures", and a very limited area is involved.

PRODUCTION AND MINES

But one or two mines have ever been operated in the county. In recent years, no mines have reported production but between 1885 and 1912 from 2000 to 6000 tons were produced annually, mainly in connection with clay mined for paving brick or sewer pipe in the vicinity of Golden Eagle.

Area underlain by workable coal	8 sq. mi.
Average thickness	24 inches
Amount available originally	17,900,000 tons
Production, year ending June 30, 1923	none
Average annual production, 1919-1923	none
Total production recorded	96,087 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The drift in the area underlain by Pennsylvanian rocks is largely loess which caps the bluffs along both the Illinois and the Mississippi. The till below the loess is relatively thin.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds outcrop in gullies of T. 13 S., ranges 1 and 2 W. The boundary of the Pennsylvanian areas can not be accurately mapped, and it is placed at the 520-foot level arbitrarily upon the elevation of the base at Golden Eagle, as well as upon the assumption of horizontal attitude. The section for the county, as given by Worthen[9], is as follows:

Typical section of Pennsylvanian strata in Calhoun County

Description of strata	Thickness	
	Ft.	*In.*
Shale, brown	6	..
Limestone, gray, concretionary	5	..
Shale, sandy brown and concealed interval	65	..
Coal	..	4
Clay shale and iron ore	2	6
Coal	2	2
Fire clay	3	..
Clay shale, grading down to black	12	..
Sandstone and sandy shale	25	..
Mississippian limestone	..	..

In this section, the prominent beds are the upper concretionary limestone which contains fusulina and the 2-foot coal near the base. According to Worthen, the black shale below this coal probably corresponds with a lower coal bed, but no such coal has been found within the county.

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[9] Worthen, A. H., Geol. Survey of Illinois, Vol. IV, p. 16, 1870.

Structure

No information is available regarding the structure of the coal beds, either for the county as a whole or for the workings of the mine at Golden Eagle. On the basis of the general geology of the region, it is assumed that the Pennsylvanian beds are essentially flat, although variations from this attitude are to be expected.

Golden Eagle Coal

So far as known, coal has been found only in the following four places in the county: the NW. ¼ of sec. 10, the NE. ¼ of sec. 24, the NW. ¼ of sec. 36, T. 13 S., R. 2 W., and in the part of sec. 1, T. 14 S., R. 2 W., in which the Golden Eagle mine was located. The coal is from 24 to 30 inches thick, appears to be relatively free from sulphur, and in general the equal of the average western Illinois coal. There is about 2½ feet of clay shale for roof, the upper part ferruginous. The 4-inch coal overlying this shale, which was classed by Worthen as a distinct bed, does not appear to be found elsewhere in the county, and perhaps should be considered a local development. Below the coal is fire clay two or three feet thick, which grades downward to black bituminous shale. The thinness of the bed makes it expensive to mine and it has therefore not been worked for the past ten years or more.

CASS COUNTY

General Statement

Cass County lies along the east margin of the area included in District III, and shows a general section resembling that of eastern Schuyler County to the north (Pl. I B). The "Coal Measures" are relatively thick and include in the thicker portion beds which overlie Rock Island and Colchester coals.

Production and Mines

Production from this area has been somewhat irregular, but at no time of more than local importance. In 1922, four mines producing less than than 7,000 tons were reported, and in 1923, six mines produced about 9,000 tons. These are in the vicinity of Chandlerville, in the northeastern part of the county, Ashland in the extreme southeastern part, and in the bluffs east of Beardstown in the western part of the county.

Area underlain by workable coal	265 sq. mi.
Average thickness	36 inches
Amount available originally	897,000,000 tons
Production year ending June 30, 1923	9,014 tons
Average annual production, 1919-1923	27,226 tons
Total production recorded	182,609 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The surficial deposits in Cass County are known to be rather heavy, as most well logs show about 100 feet of unconsolidated material over bed rock. A maximum of nearly 200 feet was reported from a well near Virginia, T. 17 N., R. 10 W. Details of the character of the deposits are lacking, however, and only a general statement is possible. Below a cover of fine loessial clay, from 5 to 20 feet thick, lie varying thicknesses of boulder clay, sand, and gravel. In places these have been found to contain much water. The floodplains of the Illinois and of the Sangamon are underlain by recent alluvium to considerable depths.

PENNSYLVANIAN SYSTEM

All of the county is underlain by "Coal Measures", except a narrow strip near Illinois River and along Sangamon River in the vicinity of Chandlerville. In these areas Mississippian rocks are exposed. The Pennsylvanian ranges from 10 feet to more than 250 feet in thickness, and shows the usual series of impure sandstone and shale with several thin limestone and coal beds. A shaft log from near Bluff Springs, T. 17 N., R. 11 W., shows the following section:

Log of shaft near Bluff Springs, T. 17 N., R. 11 W.

Description of strata	Thickness *Ft.*	Depth *Ft.*
Soil (loess)	15	15
Sandstone, brownish, with plant impressions	13	28
Limestone ("blue rock")	2	30
Clay shale ("soapstone")	12	42
Coal	3	45
Fire clay, very hard	4	49

The coal here listed is probably the same as that mined at a depth of about 200 feet at Virginia, where a boring for coal shows the following section:

Record of coal boring near Virginia

Description of strata		Thickness		Depth	
		Ft.	*In.*	*Ft.*	*In.*
Pleistocene and Recent systems		115	..	115	..
Pennsylvanian system					
Sandstone		71	11	186	11
Limestone, hard		1	1	188	..
Shale, black		2	6	190	6
Shale, clay		10	3	200	9
Coal, Colchester (No. 2)		3	6	204	3
Fire clay (base of Carbondale)		3	..	207	3
Shale, black		..	3	207	6
Shale, clay		7	6	215	..
Clay, "potter's"		13	..	228	..
Coal		..	2	228	2
Sandstone and shale		6	1	234	3
Coal	Horizon of No. 1 coal	..	3	234	6
Sandstone and shale		6	9	241	3
Coal		..	8	241	11
Sandstone and shale		16	4	258	3
Coal		..	3	258	6
Sandstone		2	9	261	3
Coal		..	2	261	5
Sandstone and shale		3	9	265	2
Clay shale		4	..	269	2
Sandstone		7	5	276	7
Rock, hard siliceous		2	..	278	7
Clay shale		2	6	281	1
Rock, hard, siliceous		3	6	284	7
Shale, hard, green		2	10	287	5

It is not improbable that approximately the lowest 10 feet in the above section belongs with the Mississippian system.

The geology of the "Coal Measures" of Cass County has been adequately discussed in an Illinois Mining Investigations bulletin[10] from which the following paragraphs are quoted:

> "Since the line of outcrop of No. 5 coal nearly coincides with the eastern boundary of the county, it is believed that most of the area is underlain by Pennsylvanian strata older than No. 5 coal, that is by strata of lower

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[10] Cady, G. H., Coal resources of District IV: Ill. Coal Mining Investigations Bull. 26, p. 62, 1921.

Carbondale and Pottsville age. These formations contain at least one, and probably two beds of coal, neither of which apparently is more than three feet thick. The most widespread of these coals is the No. 2 (Colchester, Murphysboro, or LaSalle "Third Vein") coal which outcrops along the Illinois and Sangamon valley bluffs between Bluff Springs and Chandlerville, and has been mined at Virginia at a depth of about 200 feet. It is probably this same bed which at one time was mined at Ashland at a depth of 205 feet. As the identity of this coal is not determined, and as it may be younger than No. 2 coal, it may be the same as a bed encountered in a drill hole just south of Springfield, between 50 and 60 feet below No. 5 (Springfield) coal.

"The correlation of the coal mined at Bluff Springs and Virginia is based on comparisons made by Worthen, who points out the similarity of this coal to the coal mined and outcropping at Exeter, Scott County. Observations by the writer in Scott County indicate that the coal at Exeter and Alsey is the same coal as that mined near Roodhouse and Whitehall in Greene County and at Upper Alton in Madison County, and is to be correlated with the No. 2 coal. This coal in southwestern Illinois has a roof of black paper shale, commonly called 'slate', which has a variable thickness up to about 20 feet; but in certain areas especially toward the north, gray shale or 'soapstone' lies between the coal and 'slate'. About 5 feet below the coal is a bed of limestone 2 to 5 feet thick, known locally as the 'sump rock'.

"In Cass County the coal-bearing strata dip at a low angle to the east, at the rate of 8 to 10 feet per mile. Thus, coal which outcrops along the bluff east of Beardstown is at a depth of about 200 feet at Virginia..... .....Because of the eastward dip, younger and younger rocks underlie the glacial material in that direction, so that the outcrop of the No. 5 or Springfield coal nearly coincides with the east line of the county.

"The principal coal of Cass County is undoubtedly the No. 2 bed, which underlies all the county east of Illinois Valley, probably crossing the Sangamon valley near Chandlerville. This coal is commonly between 3 and 3½ feet in thickness, and elsewhere possesses great regularity in thickness and in physical characteristics though very little is known of its physical characteristics in this county. It is probable, however, that the coal has the usual gray shale or black 'slate' roof found above No. 2 coal in adjacent counties to the south and west.....

"Because this coal is relatively so thin and its area of outcrop so small that mining by drift or slope entrance is practicable in only a small part of the county, the development of the coal resources in Cass County is probably not a matter of immediate concern. Diamond drilling should precede future development, as the data available are entirely too meager to justify undertaking mining operations."[11]

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[11] Idem, p. 64.

FULTON COUNTY

General Statement

Fulton County lies near the center of District III along the east margin, and includes within its boundary a considerable area of McLeansboro and Upper Carbondale beds (Pl. I A). It occupies a position near the margin of the thicker part of the Illinois coal basin, and is essentially a continuation of the beds of the Peoria-Springfield area. The relations to the main field are essentially the same as in Knox County, and here, as in the report of Knox County, some discussion of the eastern part of the county in which the Colchester and lower coals are not of commercial importance is included. The area included for District III is practically restricted to eight townships in the northwest part of the county.

Production and Mines

There are about as many mines in Fulton County as in any county of the State, but the total production is not great because of the great predominance of country banks. The report of the Department of Mines and Minerals for 1923 records 26 shipping mines with a total production of approximately 2,000,000 tons. In addition, there are recorded 194 local mines with a total production of slightly more than 250,000 tons. Of the 220 mines, but one of the shipping mines and 45 of the local mines belong in District III.

Stratigraphy

PLEISTOCENE SYSTEM

The Pleistocene of the county varies in thickness from 10 to about 155 feet, with an average of about 40 feet. The materials are similar to those of Knox County to the north. Glacial clay, in places containing many boulders, makes up most of the deposit. On the uplands, however, it is overlain by a yellow clay or silt, with a maximum thickness of 20 feet, and in the lowlands by recent alluvium. A small amount of sand and less gravel appears in the Pleistocene system.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds outcrop in all parts of the county, but the best exposures are in the valley of Spoon River and its branches. Spoon River exposures were combined into a type section by Worthen in his early work in Illinois and a series of seven coal beds were described and numbered. With one exception, these beds are still recognized, Worthen's No. 4 now being considered identical with his No. 5.

A large amount of drilling has been done in the county, but mainly in the eastern part where the Springfield and Belleville coals are commercially important. Much less is known of the lower beds with which this report is primarily concerned. The records from the eastern side of the county show a total thickness of between 300 and 400 feet for the Pennsylvanian, but the logs from the west margin show the system to be much thinner. One record near Marietta, T. 6 N., R. 1 E., shows 14 feet of limestone overlying about 70 feet of blue shale. These overlie Mississippian limestone, to which system some of the shale perhaps should be referred.

The Pennsylvanian section in western Fulton County shows considerable sandstone. Shale and sandy shale predominate, with limestone and coal in very subordinate thicknesses. The beds important stratigraphically are Seville (No. 1) coal and its limestone cap, and Colchester (No. 2) coal which usually can be recognized without difficulty. The relations and character of these beds are indicated in the following paragraphs taken from an earlier Survey report.[12]

"No. 2 (Colchester) coal lies about 90 to 135 feet below No. 5, the lesser interval being found in the Cuba region, and the greater in the northeast part of the county. The strata between No. 5 and No. 2 consist mainly of shale and sandstone, a massive sandstone being rather widespread in the upper third of the section. The roof of No. 2 consists of gray shale or "soapstone" 9 to 14 feet in thickness in the northern and western parts of the county, but thicker toward the south. It is followed above by a black fissile shale 3 to 6 feet thick with which is commonly found a band of fossiliferous, septarian, nodular limestone one-half to one foot thick. Savage states that this is an easily recognized succession which is exposed in many places in the western part of the county. It is noteworthy also that essentially the same succession is found above No. 2 coal in the La Salle district west of the La Salle anticline and in much of District III to the west. The coal has a common thickness of about 2 feet 6 inches, but varies between 2 and 3 feet.

"A coal believed to be the equivalent of the coal mined in Rock Island County and known as No. 1 or Rock Island coal, lies 60 to 90 feet below No. 2 coal, the interval being greatest to the east. The area in which this coal is best developed seems to lie west or south of the outcrop of No. 5 coal. The few drill holes to the base of the Pennsylvanian rocks east of the outcrop of No. 5 show coal thick enough to be of commercial value only at the horizon of the Rock Island coal in one or two cores, and these holes are located along the outcrop of the No. 5 coal in Putnam Township. The coal attains locally a thickness of about 4½ feet in the vicinity of Cuba, but there appears to be no large body of it and very commonly the seam is separated by shale partings. Where it is worked in the western part of the county at Ellisville, it is 3 to 5½ feet thick. This coal seems to have been laid down in a narrow trough or basin running north and south through the western part of the State, from Brown to Rock Island County, the eastern edge of which crossed the central part of Fulton County. Its area of main development is therefore west of this district in District III.

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[12] Cady, G. H., Coal resources of District IV: Ill. Mining Investigations Bull. 26, p. 80-81, 1921.

"No. 1 coal where characteristically developed has a readily recognizable bluish, fossiliferous, limestone cap-rock 5 to 20 feet thick, which is separated from the coal by 6 inches to 3 feet of dark shale. In its typical development this cap-rock seems to be restricted to the same area as No. 1 coal, and to become thinner and possibly disappear entirely toward the east. The few drill holes in eastern Fulton County that penetrate No. 1 coal do not find a cap-rock above No. 1 coal.

"Coals between No. 1 and No. 2 seem to be somewhat more numerous in the eastern part of the county than in the western. Between No. 1 and No. 2, lying 20 to 30 feet below No. 2. Savage reports a thin coal, 18 inches thick, which seems to be fairly persistent as it is found in outcrop in the western and central parts of the county and in drilling in the eastern part. Whereas this is the only persistent coal known in the section in the western part of the county where strata outcrop, drilling in the vicinity of Cuba, St. David, and Dunfermline reveals the presence of one or two other coals between No. 2 and No. 1. In the Cuba region the interval between No. 2 and No. 1 coals is about 80 feet. The following record of a hole drilled between Fiatt and Cuba is typical of the succession in that part of the county.

Record of drilling between Fiatt and Cuba

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene and Recent systems—				
Clay	18	..	18	..
Pennsylvanian system—				
Carbondale formation—				
Sandstone, yellow	10	4	28	4
Slate, dark	1	10	30	2
Coal (No. 5)	4	6	34	8
Shale, light	2	4	37	..
Sandstone, light	2	..	39	..
Shale, mixed	19	..	58	..
Sandstone, light	12	..	70	..
Shale, sandy	37	..	107	..
Shale, gray	20	..	127	..
"Slate," dark	1	..	128	..
Rock (limestone), dark	1	..	129	..
Shale, light	14	..	143	..
Coal (No. 2)	2	4	145	4

Record of drilling between Fiatt and Cuba—Concluded

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pottsville formation—				
Shale, sandy, light	18	8	164	..
Coal	1	..	165	..
Shale, light, sandy	12	..	177	
Shale, dark	1	..	178	..
Coal	..	4	178	4
Shale, light, sandy	18	..	196	4
Shale, dark	7	..	203	4
Coal	..	4	203	8
Sulphur (pyrite)	..	2	203	10
Coal	3	2	207	..
Sandy bottom	..	4	207	4
Rock, boulder (limestone?)	..	8	208	..
Limestone, dark	11	..	219	..
Shale, dark, hard	6	7	225	7
Coal (No. 1)	4	4	229	11
Shale, light, sandy	6	1	236	..

"The lower coal with the dark limestone cap-rock is without question No. 1. In the Cuba region rather systematic testing of this coal in certain areas reveals large variations in thickness and character. Its commercial value, therefore, for the present, at least, is small. The limestone cap-rock is commonly about 10 feet in thickness but in places is absent and in other places as thick as 20 feet. The coal overlying the cap-rock or but a short distance above it, is lenticular. In a few holes it has a thickness of about 4 feet, but commonly is less than a foot thick, and so interbedded with shale that it has no value. It is not known just how persistent this bed is in the southern part of the county. It is possible that outcrops of this bed in the vicinity of Lewiston were confused with No. 2 coal by Worthen, resulting in the misinterpretation of the section that appears in his discussion of the geology of Fulton County in Volume IV of the Geological Survey of Illinois.

"The two other coals that are fairly continuous in the section, one 12 to 20 or 25 feet below No. 2 coal, and the other about 30 feet lower, are generally thin. In some holes, however, the upper of the two is reported 2 feet or more thick, but it is more commonly found a foot or less in thickness. It is quite possible that this coal outcropping near Lewiston was the one which was confused with No. 2 coal instead of the lower coal as described in the preceding paragraph.

"Aside from the limestone and coals noted above, the strata between No. 1 and No. 2 coals are mainly shale, with a sandstone 3 to 8 feet thick rather persistent 17 to 25 feet below No. 2."

STRUCTURE

In general, throughout Fulton as in the other counties of the district, the Pennsylvanian rocks show very little deviation from a horizontal attitude. They show a slight regional dip eastward with minor upwarps west of Avon, T. 8 N., R. 1 E., and northwest of Fairview, T. 8 N., R. 3 E.

It is probable that in any area exploratory work will reveal minor variations of structure which will be of especial importance in actual mining operations. Minor irregularities in structure will be noted in the discussion of certain coal mines.

COLCHESTER COAL

From the standpoint of available tonnage, it is probable that the Colchester coal is the most important bed in that part of Fulton County which lies in District III. It has been reported from near Lewistown, Table Grove and Astoria and appears to underlie the west half of the county except where removed by erosion. Data now available do not permit mapping boundaries of this coal south of Seville, but throughout this area it has been exploited in country banks rather generally. Only a small fraction of the original tonnage has been touched, however, and when coals thinner than are now mined become important, this will become a valuable resource. It ranges from 20 to 30 inches in thickness, and is noted for its remarkable uniformity. No persistent partings accompany this bed, which is of better quality than the higher coals, and carries only a small amount of pyrite. The roof is quite uniformly gray shale 10 to 15 feet thick, called "soapstone" by the miners. In places, as in the Vermont area, the shale is sandy so that the roof in one part of the mine may be shale and in others sandstone. Over this stratum are a few feet of black fissile shale. The floor clay is generally soft, gray and plastic. Only the upper two feet are commonly penetrated, and the lower beds are not known.

ELLISVILLE COAL

The only other coal of importance in western Fulton County is that now worked at Ellisville Station, on Spoon River. This is the No. 1 bed of Worthen's type section for this part of the State, and has generally been correlated with the Rock Island coal, which it closely resembles. This bed appears to have a very irregular distribution in the county so that its importance as a coal reserve is problematical.

It is known rather generally north of Table Grove, in T. 4 N., R. 1 E., as at Marietta, Avon, Babylon, and Ellisville, but has rarely been identified south of this area. East of the limit of District III it has been reported commonly in logs, but here too it shows no regular deposition. Although fairly persistent, its thickness is so variable as to render exploitation questionable, and it commonly has partings of shale which render it worthless for mining.

It reaches a maximum of 6 feet in thickness and over considerable areas maintains an average of about 4 feet. If the entire region where it is known to be present is considered, however, it is much thinner than that and only extensive drilling will serve to outline areas of workable coal.

The Ellisville coal is of relatively high grade. It has no persistent partings and what pyrite it contains is commonly in bands or lenses which can readily be separated from the coal as it is mined.

Where normally developed, this coal has a cap-rock of limestone. In places a lower bench of this limestone comes down after the coal is removed. Elsewhere as much as 5 feet of shale comes in between the limestone and the coal. These occurrences are troublesome and expensive in mining, but where the cap is close to the coal it makes an excellent roof. The floor clay is carbonaceous for the top ten inches and softens up along roadways, but does not heave enough to give any trouble. Below this the bed is gray sandy shale which rarely softens.

MINE NOTES

The following notes taken by a member of the Survey, are introduced to show the details of the occurrence and character of the Ellisville coal:

Ellisville coal at Spoon River Colliery Company mine[13]

Entrance: shaft, 40 feet to coal.

Thickness of rock over coal: about 25 feet.

Roof: Limestone cap-rock with clod or shale below it in places. Black shale occurs in lenses and is generally found in the swags. This shale is black, carbonaceous, with some lime near the margin of the lenses. It is more solid toward the center, with less lime, and may be more than 5 feet thick. The cap limestone, with the overlying calcareous shale known as the blue rock, is in places as much as 21 feet thick.

Coal: Maximum 72 inches, minimum 36 inches, average 48 inches. No benches; much harder than Matherville or Sherrard; only slightly banded, becoming more massive near the bottom. Sulphur and sulphurous clay in lenses. Considerable mother coal in partings. Where thin, the coal contains more sulphur.

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[13] White, K. D., Mine notes in files of State Geological Survey.

Floor: Dark sandstone and shale, does not heave. The coal is interrupted by faults of small dimensions, these make steep grades in places, but are not of consequence otherwise. Figure 5 shows the usual type of dislocation.

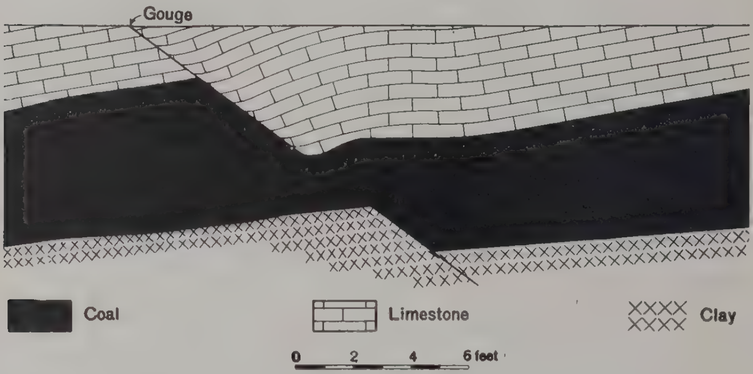

FIG. 5. Sketch showing fault in Ellisville coal.

OTHER COAL BEDS

Although not of commercial importance, other coal beds are commonly noted in drill logs from the western part of Fulton County. These are usually thin and discontinuous and can rarely be traced with certainty more than half a mile. The following extract from a report on the Avon Quadrangle is of interest in this connection:[14]

"In a number of places in the Avon quadrangle a coal bed 1 to 2½ feet thick is present only a few feet below the Rock Island bed, and is usually overlain by sandstone. This coal has been mined by drifts in a few places, as in sec. 31, T. 9 N., R. 1 E., sec. 13, T. 8 N., R. 1 W., and sec. 18, T. 8 N., R. 1 E. At the latter locality the bed is about 14 inches thick and resembles cannel coal. Many years ago it was extensively worked for the distillation of coal oil, in which process 10 retorts were at one time in operation. Thirty gallons of oil are said to have been produced from one ton of coal. At that time the clay underlying the coal was also mined and manufactured into fire brick. A coal bed belonging to this horizon is also well exposed in the banks of Cedar Creek in secs. 23 and 26, T. 9 N., R. 1 W."

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[14] Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Ill. State Geol. Survey Bull 38, p. 252, 1922.

GREENE COUNTY

GENERAL STATEMENT

Greene County lies in the southwest margin of the coal basin, and shows a more complete section of the "Coal Measures" than any of the counties south of Fulton (Pl. I B). It includes a portion of the McLeansboro, much of the Carbondale, and some of the Pottsville formations.

PRODUCTION AND MINES

Mining has at no time been very active in this county, but from a relatively early date, local banks have been worked in Colchester (No. 2) coal in the vicinity of Roodhouse, Whitehall, and Carrollton. The Greenfield bed has been exploited less continuously, but at present is producing about 70 per cent of the coal reported from the county. In 1922 the report of the Department of Mines and Minerals recorded five mines producing a total of 3,000 tons, while in 1923 the three mines listed a total of over 8,000 tons. Earlier records show as many as nine local banks with a total production of less than 10,000 tons.

Area underlain by workable coal	204 sq. mi.
Average thickness	24 inches
Amount available originally	461,000,000 tons
Production, year ending June 30, 1923	8,811 tons
Average annual production, 1919-1923	24,171 tons
Total production recorded	407,006 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The Pleistocene deposits are from 100 feet to 120 feet thick, showing the usual gray drift with yellow loess on top, the latter being relatively thin in the area underlain by the Pennsylvanian beds.

PENNSYLVANIAN SYSTEM

The "Coal Measures" underlie only the eastern half of the county, the boundary line showing marked irregularity because of the combination of the thinness of the Pennsylvanian section and the topographic relief along the major streams. Thus, there is a westward projection in the high land near Drake, in T. 12 N., R. 12 W., while the valleys of Apple Creek and Macoupin Creek cause marked reentrants of from

5 to 15 miles. A few square miles in the extreme southeastern part of the county are probably underlain by Pennsylvanian beds.

From a feather edge at the west, the Pennsylvanian thickens to more than 150 feet at the east. The rocks commonly outcrop near the margin of the Pennsylvanian area, but are mainly concealed elsewhere. A typical section for the county is given by Worthen,[15] as follows:

Typical section of Pennsylvanian strata in Greene County

Description of strata	Thickness *Feet*
Compact brown limestone	2—4
Bituminous shale	1
Coal No. 6	6
Shaly clay and nodular limestone	3—4
Shale	15—20
Bituminous shale	2—3
Coal No. 5	2—3
Arenaceous shales and sandstone	25—30
Bituminous shale, passing to coal No. 3?	2
Sandstone and shale	40—50
Coal—Tulison's and Nettle's coal No. 1	2—3
Nodular steel-gray limestone, sometimes replaced with fire clay, as at Tulison's	4 6
Shale and sandstone, passing locally into conglomerate	15—20
Total	153

From east to west, the upper beds recorded in drill logs appear to be older, the recognized McLeansboro beds extending only two or three miles into the county. The important beds in the section are the limestone cap-rock over the Belleville (No. 6) coal which is reported to outcrop in sec. 36, T. 10 N., R. 10 W., the nodular limestone which outcrops in sec. 27, T. 10 N., R. 11 W., and the 2-foot coal which outcrops in secs. 24 and 25, T. 12 N., R. 10 W. and in sec. 12, T. 10 N., R. 12 W. The relations between the coals in the various parts of the county are not well understood, since the rock section appears to vary considerably from place to place. The following sections are selected to show the character of the strata in various parts of the county. The section at Roodhouse, T. 12 N., R. 12 W. is as follows:

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[15] Worthen, A. H., Geol. Survey of Ill., Vol. III, p. 124, 1868.

Section of Pennsylvanian strata near Roodhouse

Description of strata	Thickness Ft.	Depth Ft.
Pleistocene system	73	73
Pennsylvanian system		
Soapstone	14	87
Coal, elevation 563 feet	2	89
Clay	5	94
"Cap-rock"—brecciated limestone	16	110
Shale	19	129
Slate and coal	3	132
Fire clay	3	135
Soapstone	2	137
Mississippian system		

A boring from sec. 15, T. 10 N., R. 11 W., six miles east of Carrollton records the following section:

Section of Pennsylvanian strata near Carrollton

Description of strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Pleistocene system	40	..	40	..
Pennsylvanian system				
Shale, red	4	..	44	..
Shale, black with 1-inch coal	1	..	45	..
Limestone	2	..	47	..
Shale, blue, with sand strata	108	..	155	..
Coal	...	8	155	8
Shale, blue	4	..	159	8
Shale, white	6	..	165	8
Shale, red	12	..	177	8
Shale, green	2	..	179	8
Shale, blue	30	..	209	8
Mississippian system				
Rock, white	10	..	219	8

A section near the boundary of the Pennsylvanian north of Macoupin Creek is as follows:

eSction of Pennsylvanian strata north of Macoupin Creek in Greene County

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Limestone, nodular	3	6	3	6
Shale, soft, light gray to dark	2	..	5	6
Shale, base medium gray	15	..	20	6
Shale, black	..	6	21	..
Coal	2	..	23	..
Shale, soft, grades down	1	..	24	..
Sandstone shale	15±	..	39±	..

The base of the Pennsylvanian does not appear to be as irregular as farther north, although moderate relief is in evidence in all exposures.

STRUCTURE

The Pennsylvanian beds show a regional eastward dip of low degree. Local warping, or original inequalities, appear in all the mines. Some minor fractures of one or two feet in magnitude appear in most openings. It is not clear whether these fractures and the slickensides which affect the clay associated with the coal are the result of differential slipping coincident with consolidation, or whether they are related to later movement. Detailed structural studies, as yet uncompleted in this and adjacent areas, will be the basis of a later Survey report.

COLCHESTER (NO. 2) COAL

The oldest coal mined in Greene County is that in sec. 24, T. 12 N., R. 10 W., and along Wolf Run, east of Whitehall. Essentially the same sequence of strata appears in all workings, and one from Wolf Run may be taken as typical:

Section of Pennsylvanian strata in Wolf Run east of Whitehall

Description of strata	Thickness	
	Ft.	*In.*
Shale, gray	15	...
Shale, black	..	8½
Sulphur	..	1½
Coal	..	4½
Sulphur	..	⅜
Coal	1	...
Sulphur	..	½
Coal	..	3

Section of Pennsylvanian strata in Wolf Run east of Whitehall—Concluded

Description of strata	Thickness *Ft.*	Thickness *In.*
Charcoal and sulphur	..	½
Coal	..	4½
Fire clay, soft	12	...

The coal probably underlies nearly all the area mapped as Pennsylvanian, so that with an average thickness of 24 inches a considerable tonnage of reserve coal is available when conditions permit mining thin beds.

GREENFIELD COAL

Along the eastern margin of the county there is an irregular distribution of a considerably thicker coal which lies well up in the Pennsylvanian section and may be the representative of the Belleville (No. 6) bed of Macoupin County. Some development of this coal area has been made near Greenfield, T. 10 N., R. 10 W. It has been mined also east of Rockbridge, to a lesser extent southwest of Athensville, T. 12 N., R. 10 W., and in the earlier days southeast of Roodhouse, T. 12 N., R. 11 W. The section showing its maximum development in the mine of the Greenfield Coal Company is as follows:

Section of Pennsylvanian strata in the mine of the Greenfield Coal Company

Description of strata	Thickness *Inches*
Soapstone roof	....
Top coal, thickness not measured	....
Coal	13
Shale and pyrite band	¼
Coal	5
Pyrite lens	1
Coal	18
Pyrite lens	⅛
Coal	6½
Pyrite lens	⅜
Coal	33½
Dark gray floor clay	....

The thicker coal is not known to underlie as much as one square mile in any case, so that while locally of importance, this bed can not be considered of consequence in an estimate of the resources of the county.

HANCOCK COUNTY

General Statement

Hancock County lies in the extreme west margin of the Illinois coal field, and except for certain small outliers, the Pennsylvanian beds are found only along the east margin, and they are thin in most places (Pl. I A).

Production and Mines

There are no shipping mines operating in the county, and the 1923 report of the Department of Mines and Minerals lists seven local mines, all in the vicinity of Augusta, which produced a total of 9,313 tons during the fiscal year.

Area underlain by workable coal	7 sq. mi.
Average thickness	30 inches
Amount available originally	19,270,000 tons
Production, year ending June 30, 1923	9,313 tons
Average annual production, 1919-1923	27,015 tons
Total production recorded	243,473 tons

Stratigraphy

PLEISTOCENE SYSTEM

The Pleistocene deposits are prominent over the whole county, and their thickness makes the placing of the boundary of the Pennsylvanian beds difficult. The Pleistocene varies from 20 to 75 feet in thickness, the upland having an average of 20 to 60 feet. The beds are similar to those described for adjoining counties, having loessial clay on top averaging nearly 10 feet in thickness, with hardpan or gravelly clay at the base, containing occasional lenses of sand and gravel.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds are thin, comprising sandstone and shale, with few and thin coals and some conglomerate. The outcrops of the Pennsylvanian are fairly abundant along the stream channels in the entire easternmost tier of townships in Hancock County. For the most part, the exposed sections are less than 10 feet in thickness, but locally 30 feet or more appear. In all except the southeast part of the county the outcrops are mainly sandstone with minor amounts of shale. A few inches of coal "blossom" appears in places. The maximum thickness of the Pennsylvanian is a little less than 100 feet. So great a thickness appears only in the extreme southeast part of the county where considerable thicknesses of Carbondale beds appear over Colchester (No. 2) coal. In this part of the county the upper part of the sections includes some limestone. This is perhaps the only distinctive bed in the Pennsylvanian section, but because of its limited extent, it is of no value for stratigraphic purposes. There is no other prominent bed except Colchester (No. 2) coal. Two coal beds appear in the southeast part of the county, but the lower bed is much less widespread than the upper. The interval between the two ranges from 2 feet to more than 8 feet. The following logs give a general conception of the Pennsylvanian in Hancock County:

Log of boring near Augusta, T. 3 N., R. 15 W.

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene system				
Black soil	3	10	3	10
Yellow clay	10	..	13	10
White sand	3	..	16	10
Blue clay	15	..	31	10
Boulders	4	..	35	10
Pennsylvanian system				
Slate	..	10	36	8
Soapstone	14	..	50	8
Coal	3	..	53	8
Fire clay	12	..	65	8
Sandstone	10	..	75	8
Fire clay	6	6	82	2

Another log records 55 feet of Pleistocene with 34 feet of shale and sand below. The following shaft logs indicate the succession in the extreme eastern part of the county:

Shaft log of the Augusta Coal Company

Description of strata	Thickness	Depth
	Feet	*Feet*
Shale, light gray	33	33
Coal	3	36
Clay, light gray	7	43
Coal "cannel"	2½	45½
Clay	....	....

Shaft log of the Ebben Mine, sec. 26, T. 3 N., R. 5 W.

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Surface	10	..	10	..
Sandstone, light brown	26	..	36	..
Limestone, light to medium gray	9	..	45	..
Shale, black "slate"	6	..	51	..
Shale, gray "soapstone"	32	..	83	..
Coal	3	..	86	..
Clay, light gray	2	6	88	6
Coal	2	2	90	8
Clay	3	..	93	8

The Pennsylvanian beds lie in overlap relations to the Mississippian limestone series below. This lower surface is somewhat uneven, but the records do not show the marked relief which appears in adjoining counties. More detailed information will doubtless reveal the presence of greater irregularity than now appears.

STRUCTURE

The Pennsylvanian beds, while maintaining a general flat attitude, probably have a slight eastward dip. Minor warping is marked where mining operations have made it possible to follow given beds for any distance. Thus, in the Williams Creek area, the coal shows a general southwest and west dip, in places this being compensated by equivalent eastward and northeastward dips. These show inclinations as high as seven degrees for 100 yards. Whether these variations in altitude are original and represent irregularities in the basin of deposition, or whether they are warps induced by subsequent folding, is not clear from present data. The fact that the coal commonly becomes thinner in places where it is higher favors the idea that these basins are original and not structural.

COLCHESTER COAL

The only coal field in the county important at present is in the extreme southeastern corner in T. 3 N., R. 5 W. where Colchester (No. 2) coal from 24 to 36 inches thick underlies an area estimated at about seven square miles. It has no persistent parting, although the upper part is usually harder and brighter than the lower. A typical section is as follows:

Typical section of Colchester coal in southeastern Hancock County

Description of strata	Thickness	
	Ft.	*In.*
Gray shale roof	..	....
Pyrite	..	1½
Coal	..	4¾
Pyrite	..	½
Coal	..	7¾
Pyrite	..	¼
Coal	..	16½
Underclay	4	....

The lower part shows more distinct banding of bright and dull coal, and a larger per cent of charcoal. The roof of this coal is gray shale uniformly in this county, although a few miles to the east in Schuyler County the shale is replaced by sandstone. The floor material is as usual for Colchester (No. 2) coal, a light gray plastic clay. No other coal is worked in this county, except in those places where the lower bed, as at the Ebben mine, is separated from the main bed by only two or three feet of shale. This lower bed is commonly called the "cannel coal" from its subconchoidal fracture and its massive appearance. While resembling the cannel coal, it possibly does not have the chemical or organic composition which is essential for a true cannel.

Other Coal Beds

West of the main boundary of the coal field in Hancock County, as mapped in Rs. 5 and 6 W., are one or more isolated patches of coal which have been worked or reported. These may be connected with the main field but more likely constitute outliers both of the coal and of the Pennsylvanian beds as a whole. Such a one appears in sec. 34, T. 3 N., R. 6 W. Coal was similarly reported along Crooked Creek in T. 5 N., R. 6 W. This coal was 12 inches thick, and presumably lies below the regular Colchester coal, although it may be the thin western edge of that bed. Old coal workings are reported from sec. 13, T. 4 N., R. 8 W., and a 14-inch coal was reported from sec. 4, T. 5 N., R. 8 W., and sec. 32, T. 6 N., R. 8 W. At Nauvoo a thin coal was found immediately below the drift, and was stripped at an early date by the Mormon settlers.

It thus appears that over most of the county there is a possibility of finding thin patches of Pennsylvanian rocks with or without coal. While coal in this general area may reach a thickness sufficient to make it possible to mine, it will never be found sufficiently widespread to make more than local mining attractive. When the Mississippian surface is known in greater detail, probably it will be found that the majority of the Pennsylvanian rock patches constitute outliers separated from the main coal field by distances ranging from 1 to 20 miles.

HENDERSON COUNTY

General Statement

Henderson County lies on the western margin of the Illinois coal field so that only the southeastern portion of the county is underlain by Pennsylvanian strata (Pl. I A). Within this area the workable coal is confined to the SE. ½ of T. 8 N., R. 4 W.

No shipping mines have ever been operated in the county, and no local banks have been commercially operated for many years, although in the past some coal has been dug in sec. 26, T. 9 N., R. 4 W.

Area underlain by workable coal	22 sq. mi.
Average thickness	29 inches
Amount available originally	59,580,000 tons

Stratigraphy

PLEISTOCENE SYSTEM

The Pleistocene is reported 16 to 80 feet thick, being thicker in the southeastern part of the coal area where it effectively conceals the bed rock. The deposit comprises yellow and blue clay with subordinate sand and gravel.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds are thin; the maximum thickness reported is in sec. 25, T. 9 N., R. 4 W., where it is less than 40 feet. The only known outcrops of Pennsylvanian beds are in the northwest part of T. 8 N., R. 4 W. (Raritan Township) and along the small creek in the NE. ¼ sec. 26, T. 9 N., R. 4 W. These reveal gray-white sandstone underlain by thin coal in places, elsewhere by shale or more shaly sandstone. Drilling shows the sandstone to be as much as 30 feet thick and to make up most of the Pennsylvanian section. The uppermost sandstone is probably continuous over the Pennsylvanian area, probably overlapping the lower coal-bearing beds on the west and hence underlain there by the Mississippian beds. Two coals appear in the area, and if the reported logs can be relied upon, there is still another carbonaceous zone which includes coal in places. The uppermost coal lies more than 700 feet above seal level. The next lower is at about 680 feet, while the questionable zone is at about 650 feet.

The uppermost is the best known, and probably the most valuable. It has been identified as the Colchester (No. 2) coal, and appears to have its best development in T. 8 N., R. 4 W., where it is reported about 30 inches thick. It has also been mined in T. 9 N., R. 4 W. in a small way. The roof is sandstone, locally conglomeratic, and is somewhat fractured so that workings must be carefully timbered. The floor is gray plastic underclay several feet thick. The other coals are known only from drill logs, and have similar roof and floor. They vary in thickness from 6 to 36 inches.

HENRY COUNTY

General Statement

Henry County lies near the northern edge of the Pennsylvanian area and hence includes a portion of its boundary in the northern townships (Pl. I A). Because of the excessive thickness of the drift, the exact position of this boundary can not be determined. It lies approximately parallel to and a little south of Green River in the eastern part of the county, bending north to Rock River a little east of Geneseo, and following the Rock to the western edge of the county. Thus the southern three-fourths of the county is underlain by "Coal Measures" and within this area mining has been done in most of the marginal townships leaving a group of six in the interior, Tps. 15 and 16 N., Rs. 2, 3, and 4 E., which are scarcely prospected.

Production and Mines

Local mines are operated in most parts of the county, although but one shipping mine is now running. There are several mines in the vicinity of Kewanee, some near Geneseo and Briar Bluff and a recently opened mine near Warner. To the south is the new Shuler mine, located at Alpha on the Chicago, Burlington and Quincy Railroad.

The 1923 report of the Department of Mines and Minerals lists 17 local mines, having a total tonnage of 58,074 for the fiscal year.

Area underlain by workable coal	307 sq. mi.
Average thickness	43 inches
Amount available originally	1,247,530,000 tons
Production, year ending June 30, 1923	58,074 tons
Average annual production, 1919-1923	190,425 tons
Total production recorded	4,754,791 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The surface covering of Henry County ranges from a few feet to more than 125 feet in thickness. It is relatively thin along the northern margin of the coal itself, although thicker at the north margin of the coal-bearing beds. Differences in thickness amounting to more than 100 feet are known in the same township, near Annawan, where a deep post-Pennsylvanian valley is suggested by drill records. The surficial materials comprise the usual glacial till with interbedded sand and gravel locally covered with varying thickness of loess. Slopes covered with this light clay are easily gullied by rain wash, so that

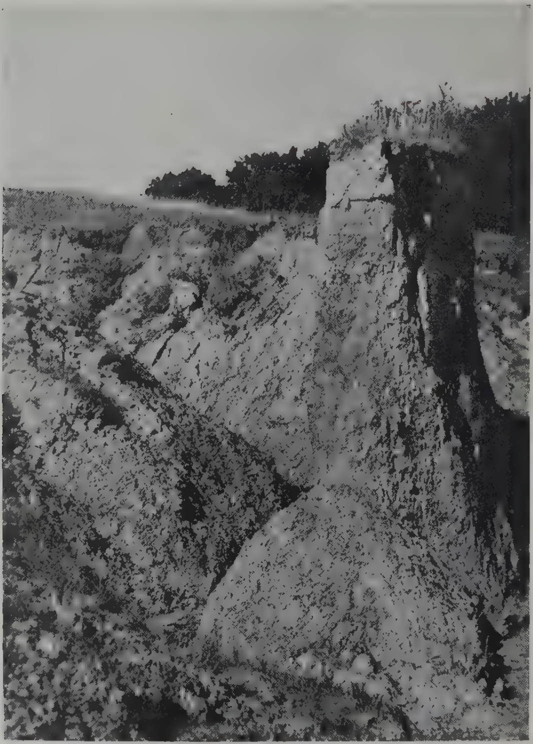

Fig. 6. Loess slope gullied by rainwash. Remnant shows tendency of this material to stand in vertical walls when capped by sod. Henry County.

otherwise valuable farm land is rendered unsuitable even for grazing purposes. Figure 6 shows the character of this erosion, and illustrates well the tendency of the loess to stand with vertical walls. Because of this heavy cover of drift and alluvium, the bed rocks of the area are but rarely exposed.

PENNSYLVANIAN SYSTEM

Outcrops of the Pennsylvanian beds are confined to the valley of Rock River above Cleveland, to Mineral Creek east of Briar Bluff and its main tributaries from the south, and to the vicinity of Galva. Even these exposures are limited, and reveal but a few feet of beds at any point. The best outcrops are in the neighborhood of Briar Bluff where the Pennsylvanian system is thin and the basal beds exposed lie but a few feet over the Devonian limestone. Here the following section has been described:

Section of Pennsylvanian strata exposed near Briar Bluff, Henry County

Description of strata	Thickness	
	Ft.	*In.*
Sandstone, light to medium gray, platy, carbonaceous partings, base uneven	16	..
Limestone, argillaceous, dark gray, upper part massive, lower less clayey	2	..
Clod, well jointed, dark	..	9
Coal, with shale parting	4	..
Concealed	10	..
Sandstone, light gray, thin-bedded, grades in basal 10 inches to black shale	4	..
Shale, black to dark gray, several bands of clay ironstone concretions, base concealed	22	..

Very few logs record the beds below the upper coal of the county so that there is little information as to the thickness and character of the Pennsylvanian. A well at Kewanee, which records what appear to be Pennsylvanian beds at 200 feet, has no record for the next lower 196 feet so that there is a possibility that the system is 324 feet thick there. Another record at Kewanee shows 286 feet of strata above the Devonian limestone. A log from near Galva records what appear to be Pennsylvanian beds for 332 feet. In the vicinity of Alpha, a total of 365 feet of strata overlies the first thick limestone. To the north, along Rock and Green rivers, the "Coal Measures" thin to a feather edge. Here the uppermost beds are apparently identical with those which lie near the top of the section in the southern portion of the county. This relationship strongly suggests that the beds making up the lower part of the thick Pennsylvanian section in the southern part of Henry County do not extend to the north edge of the coal field and are distinctly older than the beds outcropping there.

Comparison of data from all parts of the county indicates that the Pennsylvanian system includes a large amount of shale, which is in part sandy, sandstone being much more prominent in the upper part of the section than in the lower.

Few beds in the entire section are identifiable over any large part of the county. Identification is almost impossible from drill logs, and over much of the county there are no mines or outcrops. The 4-foot coal mined at Galva and Kewanee with its cap limestone is recognizable over the southeastern part of the county. Similarly, the Rock Island coal and its cap-rock are known to underlie a large part of the area west and north of Cambridge. Below this coal there is commonly found a thick bed of dark gray to black shale. Aside from these, no beds are known to have a wide distribution in the county.

Coal beds are found in all parts of the county. They are not restricted to any one part of the Pennsylvanian system, but come in at irregular intervals, in the upper or lower part. At the north where the total section is thin, there are rarely more than two coals found, and of these in many places only the lower is thick enough to work. Farther south, both at the east and west, several beds are found, as in the following log:

Log of boring in southern Henry County

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Upper clays and sand	50	..	50	..
"Slate", gray	3	..	53	..
Sand rock, white	4	..	57	..
"Slate", black, gritty	2	..	59	..
Coal	2	9	61	9
Fire clay, white	..	9	62	6
Coal	..	10	63	4
Fire clay, light blue	3	11	67	3
Rock, hard, gritty	4	..	71	3
Sand shale, blue	4	..	75	3
Sandstone, bluish	7	..	82	3
Shale, blue	14	..	96	3
Shale, gray	39	..	135	3
"Slate", black	4	1	139	4
Coal	..	11	140	3
Fire clay, blue	4	..	144	3

Log of boring in southern Henry County—Concluded

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Sand shale, light	6	..	150	3
"Slate", black	1	..	151	3
Shale, blue	3	..	154	3
Rock, white, gritty, (like limestone)	3	..	157	3
Shale, blue	4	..	161	3
"Slate", gray	2	..	163	3
Shale, blue	4	..	167	3
Shale, light, gritty	22	..	189	3
"Slate", gray	31	..	220	3
"Slate", dark	22	6	242	9
Blue rock, dark	3	4	246	1
Coal	..	4	246	5
Fire clay, white	5	10	252	3
Sandstone, light	8	..	260	3
Shale, blue	13	..	273	3
Shale, brown	2	..	275	3
Shale, light blue	15	..	290	3
Medium dark shale	5	..	295	3
Shale, light	7	...	302	3
Shale, dark	1	..	303	3
Sand rock, white	2	..	305	3
Coal	2	7	307	10
Fire clay, light	8	5	316	3
"Slate", dark	7	..	323	3
Rock, white gritty	5	..	328	3
"Slate", black	5	..	333	3
Coal	1	..	334	3
Fire clay, light	3	..	337	3
Fire clay, white	10	..	347	3
Rock, hard flinty	1	..	348	3

The relations between the coal beds in the several parts of the county are not known, but it appears that the lower coals thin and pinch out northward as the pre-Pennsylvanian surface rises. Lack of records of deep drilling makes it impossible to even suggest the character of the pre-Pennsylvanian surface.

STRUCTURE

The basin in which these beds were deposited apparently had a gentle slope to the south and this presumably gave the marginal strata a tendency toward a southerly regional dip. Aside from this, there is slight evidence of any general deviation from the horizontal.

Local variations from the horizontal are common. Thus, in the Briar Bluff area, the Rock Island coal shows 22 feet of relief in half a mile, and near Sunny Hill shows 88 feet. It maintains the same general elevation, however, over more than five townships. Similarly, near Kewanee the Sheffield coal ranges from 685 to 748 feet above sea level, and shows but little more relief in the whole district between Sheffield and Galva.

Sheffield Coal

The main coal field is in the southeastern part of the county—the Kewanee-Galva area. The Sheffield coal which formerly was mined in a number of places near Galva is now mined rather extensively north of Kewanee. This bed has not been positively identified in other parts of the county although one of the beds of the Alpha section will probably be correlated with it. In the mines the bed is about four feet thick, but since the workings are restricted to the thicker coal, it is probable that outside the area in which the coal is mined it averages less than three feet. Future exploration may, however, show a number of small basins similar in extent and character to those about Kewanee and Galva in which this coal is sufficiently thick to be commercially important. In estimating the resources, the entire area is assumed to contain coal 42 inches thick.

The coal bed commonly has a shale parting of two inches or less, which separates the bed into two benches. This parting is not readily separated from the coal and causes considerable loss; in some mines this band, together with all pyrite lenses, is gobbed so that an especially clean coal is produced. The upper bench is commonly separated by two or more charcoal partings which are discontinuous and which do not split the coal into definite benches.

The roof is quite satisfactory in most mines. It is black fissile shale, the "slate" of the miners, and has a limestone from 4 to 72 inches above it. This limestone is the usual cap-rock of the Belleville (No. 6) coal of the Illinois section, and ranges from 18 to 24 inches in thickness.

The floor of the coal is a gray clay, ranging from 18 to 48 inches in thickness. It is usually so dry and hard as to give little trouble from heaving. Locally it contains carbonaceous matter in which excellent plant fossils have been found.

In most mines of the district, clay slips or "horsebacks" are common. No part of the area seems to be free from them, although they may be encountered only in one part of a given mine. These slips are similar to the well known dislocations of the No. 5 coal of the Springfield-Peoria district. Each slip involves a zone varying from less than 6 inches to several feet in thickness. The contact of the clay and the coal is very irregular, the fingers of clay extending into the coal for about 6 inches on either side of the main body. Ordinarily there is no thickening of the coal at these slips, but instances of this have been recorded.

The coal bed is affected by the usual irregularities in roof and floor, rolls in either or in both, nearly cutting out the coal for a few yards.

Rock Island Coal

An extension of the main body of Rock Island coal is found in the extreme northwest part of Henry County, in two small areas. The larger includes part of T. 17 N., R. 1 E. and the north part of T. 16 N., R. 1 E.; the smaller lies in the vicinity of Cleveland in T. 18 N., R. 2 E. This coal reaches more than 60 inches in thickness where mined, but is thought to average less than 48 inches for the area.

The coal is identical with that mined to the west in the Coal Valley area. It is not a hard coal, although the upper bench is harder than the lower where it shows a shale or other persistent parting. Elsewhere, it is apparently uniform in character from top to bottom. It breaks with an irregular fracture but shows no regular jointing.

Roof conditions are generally satisfactory. The coal is covered by a black fissile shale or "slate", which in some places comes down with the coal, but is ordinarily a safe top. Above the "slate" there is commonly a thin limestone. This is absent in places, probably through non-deposition. The floor is the usual underclay, light in color, hard, tough, and firm. In most places it makes an excellent working floor, although in places there is a tendency for the coal to "freeze" to the floor. Some of the older mines of the State were sunk in this coal and in the Cleveland area this coal is essentially worked out. In the Warner field there is still a considerable tonnage in the ground.

Alpha Coal

In the vicinity of Alpha, recent exploration has resulted in the development of a new field for Henry County. This probably includes an area considerably larger than that blocked out for the present operations. On the basis of available data, this field is mapped to include part or all of Tps. 14 and 15 N. of Rs. 1 and 2 E.

The coal that is worked lies at a depth of about 200 feet and over part of the field at least it has an average thickness of nearly five feet. Two other coals overlie this thicker bed. Present information suggests a correlation of the lowest coal with the main bed of the Rock Island section at the north.

OTHER COAL BEDS

Very little mining is done outside of the areas so far outlined. Stretching east and west of Geneseo for several miles is an elongate field of unknown boundary in which a coal has been mined locally for many years. At the west end is the old Mineral Creek field underlain by a 3-foot coal and locally by an upper and thinner bed. At the east a similar bed was mined at shallow depth near Atkinson. Near Geneseo a 44-inch bed outcrops in the creek and was formerly worked by shaft. For purposes of estimating the probable reserves of the county, these three small fields are combined. It appears probable that in the unmapped area to the south, there is enough coal to more than make up for the lack which may exist in the area mapped as coal land.

Two other small patches in Henry County are known to contain some coal, one near Cambridge and one near Bishop Hill. One of the earliest mines of this part of the State was located in the Bishop Hill region. These areas are of unknown extent, but possibly are not connected with any of the other fields in the county. The coal at Cambridge was reported by Shaw[16] to be about 3 feet thick at the shaft and to thicken toward the south. Neither of these is included in the estimated coal land and tonnage of this county.

Additional coal beds are recorded in drill logs. These are more numerous in the southern part of the county where the Pennsylvanian system is thicker than farther north. In the vicinity of Warner and Lynn, two additional coal beds are recorded. Two are also found in the Alpha area, while near Galva, five coals besides the Sheffield bed are listed. Although in most cases the additional coal beds are too thin to be of importance, they have been found in workable thickness, and it is probable that a small tonnage might be recovered from them. Like the minor coal beds of Mercer County, however, they were apparently deposited in basins of small dimensions, and are probably characteristically thin and bony.

JERSEY COUNTY

GENERAL STATEMENT

Jersey County includes a portion of the southwest margin of the Illinois field, and only the eastern half of the county is underlain by rocks of "Coal Measures" age (Pl. I B). Of this area, probably less than half is included in District III.

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[16] Shaw, James, Geol. Surv. of Ill. Vol. V, p. 195, 1870.

PRODUCTION AND MINES

The only mines in the Pottsville or Carbondale coals are in the vicinity of Delhi, where Colchester (No. 2) coal is mined in a few local banks. In 1923, no production was reported from mines in that portion of Jersey County included in District III, although a small tonnage was mined about 1890.

Area underlain by workable coal	11 sq. mi.
Average thickness	24 inches
Amount available originally	24,600,000 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The cover of Pleistocene is fairly uniform over the upland, concealing all preglacial irregularities, and giving a rather smooth upland surface. This has been so incised by streams as to produce surface relief amounting to more than 150 feet. The surficial materials include a few feet of loess with the usual bouldery till below. Limestone boulders from the underlying Pennsylvanian rocks predominate in the till.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds are not well exposed in the western part of the area underlain by this series. Along Piasa Creek a fairly complete section is obtained in Tps. 7 and 8 N., R. 10 W. On the basis of these and similar outcrops, the western margin of the area underlain by McLeansboro beds is indicated on the map along the line slightly west of Kemper, Fidelity, and Brighton. In the area assigned to District III the Pennsylvanian beds overlie the St. Louis limestone of Mississippian age, and show a maximum thickness of less than 100 feet. Very little information is available for any of the area, except near Delhi, T. 7 N., R. 10 W., where a few borings and one or two small openings on the coal have been made. A typical section for this area is as follows:

Typical Pennsylvanian section near Delhi

Description of strata	Thickness	
	Ft.	*In.*
Surface	10	..
Shale, gray "soapstone"	20	..
Shale, black, fissile	1	..
Coal	2	6
Underclay, gray plastic	3	6
	37	

STRUCTURE

The Pennsylvanian beds appear to have a general easterly dip, which is more marked near the west margin of the coal field because of the post-Pennsylvanian deformation which brings the Mississippian strata to the surface in the neighborhood of Jerseyville. No data are available relating to the details of the structure, which will be presented in a forthcoming report on the geology of Jersey County.

DELHI COAL

North of Delhi is an area of about ten square miles, which is apparently underlain by a thin coal, locally called Colchester (No. 2). In outcrops or in mine workings the coal is about 26 inches thick, occurs without partings, and locally carries much sulphur in the form of pyrite. The roof is black fissile shale, the floor, soft plastic clay several feet thick, underlain in some places by a nodular and brecciated limestone.

Elsewhere, there is probably a patchy development of one or more coal beds which belong in the lower Carbondale or Pottsville series. Such beds have been noted in places, but are apparently never of sufficient thickness and extent to be of value.

KNOX COUNTY

GENERAL STATEMENT

Knox County lies near the west margin of the Illinois coal field and has representatives of all three divisions of the Pennsylvanian system (Pl. I A). It includes a part of the margin of the McLeansboro formation which covers the eastern two-thirds of the county. Only the western tier of townships is included in the area known as District III. For purposes of comparison, however, there is included in this report a brief discussion of all the coal in the county so far as information regarding it is at hand.

PRODUCTION AND MINES

There are no shipping mines at present being operated in Knox County, and the number of local mines varies considerably from year to year. In 1923, a total of 39 mines producing a total of 51,528 tons was reported by the State Department of Mines and Minerals. These mines are located in the western and north-central parts of the county. The largest operations at present are at Soperville.

Area underlain by workable coal	**517 sq. mi.**
Average thickness	**36 inches**
Amount available originally	**1,727,000,000 tons**

Stratigraphy

PLEISTOCENE SYSTEM

Knox County is almost entirely covered with a deposit of glacial material which ranges from about 10 to 85 feet in thickness. The thickness is variable in all parts of the county, and in places considerable unevenness in the underlying rock surface has been concealed by corresponding uneven deposition of the glacial materials. These deposits comprise the usual sands, gravels and boulder clays, in beds of irregular extent. Yellow and blue clays are commonly noted in logs from the western part of the county. The yellow clay is a loess-like deposit perhaps largely of wind-blown material.

PENNSYLVANIAN SYSTEM

The whole county is underlain by strata of the "Coal Measures". The exposures of these strata are not uncommon, but the sections visible are so limited vertically and horizontally that little can be learned from them as to the character of the system as a whole. So far as the western part of the county is concerned, outcrops are found near Soperville, east of Wataga, near the plant of the Purington Brick Company east of Galesburg, and to the south along Cedar Creek west of St. Augustine.

Relatively little drilling has been recorded in Knox County, and the available data comes from one or two localities so that there is little information for most of the county. In rare instances, the drill has penetrated beds below the Pennsylvanian and from these records it is clear that the Pennsylvanian beds are thicker here than to the north or west. As much as 300 feet of strata are reported from near Knoxville, and nearly 350 feet from a boring in T. 12 N., R. 1 E. In the latter record, it is not clear that all of these beds belong in the Pennsylvanian. The system is possibly somewhat thicker in the east than in the west, but the difference is not apparent from available records.

As elsewhere in the district, the beds of the "Coal Measures" are largely shale, in places very sandy. True sandstones are not common but are found at any horizon in the section. Limestones are rare, and practically confined to the upper part of the series. As many as five or six beds of coal have been reported in some of the borings, but most of these are thin and of little or no value. The following log from the western part of the county is typical for the region, and serves to emphasize the marked vertical variation exhibited by these rocks:

Record of boring in western Knox County showing typical Pennsylvanian strata

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Clay, sandy	..	..	20	..
Shale, gray	33	..	53	..
"Slate", dark	2	1	55	1
Coal	1	2	56	3
Shale, gray	2	7	58	10
Sand rock, light, very hard	3	2	62	..
Shale, light	2	2	64	2
Sand rock, light, moderately hard	1	4	65	6
Shale, light	15	3	80	9
Boulder rock, light, very hard	2	2	82	11
Shale, gray	8	1	91	..
Shale, brown sand	29	..	120	..
Sand rock, gray, moderately hard	15	4	135	4
Shale, dark	7	11	143	3
Lime rock, blue, very hard	2	..	145	3
Shale, dark	7	9	153	..
"Slate", dark	1	11	154	11
Coal	1	7	156	6
Impure coal	..	2	156	8
Coal	..	4	157	..
Fire clay	2	..	159	..
Sand rock, white, very hard	8	10	167	10
Sand shale, light	4	10	172	8
Sand shale, gray	7	8	180	4
Sand shale, light	5	8	186	..
Coal, soft	1	..	187	..
Sand shale, light	2	2	189	2
Lime shale	4	4	193	6
Sand rock, light, very hard	3	10	197	4
Sand shale, light, moderately hard	1	4	198	8
Sand rock, light, very hard	4	2	202	10
Sand shale, light, very hard	7	6	210	4
Shale, gray	2	7	212	11
Coal	1	2	214	1
Sand shale, gray	5	11	220	..
Sand rock, gray	..	6	220	6
Shale, dark	1	8	222	2
Cap rock, extremely hard	1	1	223	3
Impure coal	2	4	225	7
Sand rock, gray, very hard	..	10	226	5
Sand rock, light, very hard	3	3	229	8
Sand shale, light	7	4	237	..
Sand shale, gray	10	3	247	3

Record of boring in western Knox County showing typical Pennsylvanian strata—Concluded

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Coal	..	11	248	2
Shale, gray	3	6	251	8
Shale, light gray	4	..	255	8
Sand shale, gray	8	1	263	9
Coal	..	3	264	..
Fire clay	1	4	265	4
Sand shale, gray	4	1	269	5
Coal	..	2	269	7
Sand shale, light	..	10	270	5
Sand rock, light, very hard	2	8	273	1
Slate, dark	10	6	283	7
Sand rock, light, very hard	1	6	285	1
Shale, dark	36	..	321	1
"Slate", dark, very hard	15	10	336	11
Sand rock, light, very hard	2	6	339	5

In the early Survey report,[17] the boundary of the Belleville (No. 6) coal area was extended from Galva in Henry County southwest through Oneida, thence south to the vicinity of Maquon and south into Fulton County. Considerable similarity between the rocks in eastern Henry and eastern Knox counties would therefore be expected. Essentially the same section as noted for the Kewanee field, including the fusulina limestone, some shale, and a 4-foot coal with charcoal and shale partings is found near Etherly, Victoria, and Wataga, and hence the Etherly coal is correlated with the Sheffield coal.

As in Henry County, the drill records in Knox County which go below the Etherly coal show several lower coal beds. These have commonly been labeled Nos. 5, 4, 2, and 1, on the assumption of proper correlation for the topmost bed. In places, however, a coal is recorded 15 to 20 feet above what is called the Etherly bed. The beds below the Etherly bed are not reported with sufficient regularity to indicate any definite interval at which coal may be found. It is believed that they represent the irregular deposits of Pottsville and Carbondale time made near the margin of the coal-forming area.

STRUCTURE

Essentially the same structural relations as those reported for Henry County are found in Knox County. On the basis of correlation outlined above, the Etherly or Sheffield coal is somewhat lower in eastern Knox County than in southeastern Henry County and continues to dip to the west. This, however, is relieved by local variations which are less marked than in the Henry County area. This attitude of the Etherly coal probably fairly reflects the structure of the lower beds of the system. So far as the coal is concerned the regional structure is of no consequence. The local deviations from this structure, in places involving only about one square mile, are somewhat more important. In no case, however, is the coal found to lie in the steep sided basins which characterize the Mercer and Warren County fields. It is probable that further exploratory work will reveal some such local warping, but the general character of the deposits indicates that uniform conditions obtain over wider areas than in the counties to the west.

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[17] Green, H. A., Geol. Survey of Illinois: Vol. IV, p. 314, 1870.

Minor dislocations of the coal bed, clay slips and rolls are found in this area as elsewhere. These will be noted in connection with the description of the several coal beds.

Soperville Coal

At the present time, about half of the coal of the county comes from the Soperville field north of Galesburg. The position of this bed in the Illinois general section of "Coal Measures" has not been finally determined. It appears to lie too high to be correlated with the Colchester or No. 2 bed, and perhaps too low to be classed with the Springfield (No. 5) coal. The latter correlation has been made tentatively, although earlier reports classed this bed with the Rock Island coal. Detailed stratigraphic studies in the area will be needed to complete the correlation.

The Soperville bed is not known to extend widely over the county. So far as known, it is restricted to parts of Tps. 12 and 13 N. of R. 1 E. in this county and probably extends west into northeastern Warren and southeastern Mercer counties.

The bed has an average thickness of about 48 inches, reaching a maximum of 72 inches in one of the mines. Locally, it is practically cut out beneath surface materials so that it is unworkable. The bed is normally in three benches, with a charcoal and dirt parting below the top bench and a shale-pyrite parting above the lowest one. The top bench is relatively brittle, and has abundant calcite facings throughout. The middle bench is less dull, more laminated and harder than the top. The bottom bench is the hardest coal, and is somewhat more dull than the others. Locally the top few inches is nearly a cannel coal, showing few laminations and a distinct conchoidal fracture.

The roof is shale, mainly black and locally fissile. It ranges up to 18 feet in thickness, but gives trouble and must be supported by the top coal in places. The shale contains large calcareous and pyritic concretions which commonly fall when the coal is removed. There is no widespread limestone cap-rock such as overlies the Etherly coal. The floor is rather hard, slightly flinty clay at the top with softer clay below. This is light gray in color, and more than six feet thick.

The coal bed is interrupted by "horsebacks" and "clay-slips" and by small faults of little displacement. The flaring V-shaped slips are the most troublesome in mining, as they increase the hazard and cost, besides reducing the area of workable coal perceptibly. The character of this type of fault is illustrated by figure 7.

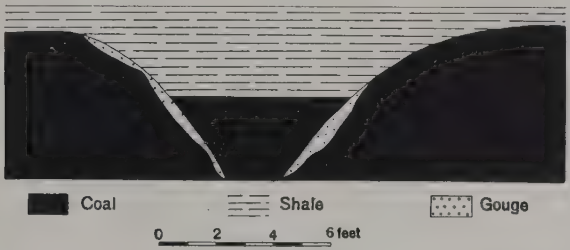

FIG. 7. Diagram of fault in Soperville coal in Knox County.

ETHERLY OR SHEFFIELD COAL

In the Etherly area, which includes the eastern two-thirds of Knox County, the same general succession of beds described for the Kewanee field is present. The early reports show the Sheffield bed to underlie eastern Knox County as far as a line connecting Oneida, Wataga, and Maquon. Since this area lies outside of District III and has been described in some detail in an earlier bulletin[18] it will not be considered further here.

ABINGDON COAL

A small amount of coal is spasmodically mined from the Abingdon field. The extent of this coal is not well known, but recent drilling indicates that it extends northward to within three miles of Galesburg and eastward somewhat beyond Spoon River. It is normally about two feet thick, without partings, and of fair quality. It is bright and hard and commonly contains lenses and balls of pyrite. The roof is shale, black and fissile, and overlain by another shale, non-gritty, gray in color, known as "soapstone". The section here is similar to that of the Colchester coal.

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[18] Cady, G. H., Coal resources of District IV: Ill. Mining Investigations Bull. 26, p. 106, 1921.

Other Coal Beds

Practically throughout the county, drill records show more than one bed of coal. A log from the extreme northeast corner of the county shows six unidentified beds, only one of which is of workable thickness. The record from western Knox County shows eight beds of coal; three beds are reported from the Etherly field. Most of these beds appear to be of irregular development and may be of workable thickness in one place but pinch out to a few inches within short distances.

In the St. Augustine area the Rock Island bed, lying a few feet below the Colchester bed, is thick enough to be worked in a small way. It seems to underlie only the southwest part of the county, in Tps. 9 and 10 N. of R. 1 E. It shows the same characteristics here as are noted in the adjoining part of Warren County. It is about 30 inches thick, with or without a shale parting, and is of fair quality. The shale roof with limestone capping makes it easy to work. The light gray clay floor gives no trouble by heaving.

MADISON COUNTY

General Statement

Madison County is at the extreme south end of District III, and in its general relations duplicates Jersey County to the north (Pl. I B). As indicated on the map, the area assigned to District III is a northwest-southeast strip about 4 miles wide extending west as far as East Alton, and Godfrey, and bounded on the east by the outcrop of younger strata which include Rushville (No. 5), Belleville (No. 6), and higher coals.

Production and Mines

At the present time, production from the lower coals in Madison County is from four or five country banks in the vicinity of Upper Alton producing less than 10,000 tons annually. These mines were formerly of more importance, as they produced more than 100,000 tons each year. The later discovery of thicker coal to the east has caused the decline in production from this field.

Area underlain by workable coal	29 sq. mi.
Average thickness	24 inches
Amount available originally	65,750,000 tons

STRATIGRAPHY

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds are rarely exposed in outcrop, and are known mainly from the coal openings and one or two borings. In the vicinity of Upper Alton, the limited data reveal coal overlain by shale, and in places underlain by clay with limestone. Following is a typical log from farther east in the county, recording the McLeansboro beds but showing the character of the Lower Pennsylvanian beds as well:

Log of boring in Madison County showing the succession of Pennsylvanian strata

Description of strata	Thickness *Feet*	Depth *Feet*
Clay, sand and gravel	156	156
Shale, (with thin coal)	4	160
Clay shale, with soft lime nodules	7	167
Clay shale	3	170
Lime shale	12	182
Shale, mixed	3	185
Clay shale	3	188
Limestone, fossiliferous	3	191
Clay shale	1	192
Shale, black	1	193
Clay shale	9	202
Clay shale, with soft lime chunks and thin coal	2	204
Shale	2	206
Limestone	10	216
Shale, soft (base of McLeansboro formation)	4	220
Coal	5	225
Clay shale	6	231
Limestone	2	233
Clay shale	15	248
Lime shale	3	251
Lime shale, sandy	49	300
Shale, blue	13	313
Coal	1	314
Shale, sandy	22	336
Shale, blue	16	352
Limestone	2	354
Slate	2	356
Coal	3	359
Shale, blue	3	362
Shale (base of Pennsylvanian system)	13	375
Shale and limestone of Mississippian system	275+	650+

A mine in sec. 6, T. 5 N., R. 9 W. shows the following section:

Section of coal in mine located in sec. 6, T. 5 N., R. 9 W.

Description of strata	Thickness *Inches*
Roof shales with some sandstones	..
Coal	24
Coal, bony	3
Shale band "blue band"	5
Underclay	

Most of the coal of the main bench is dull and distinctly laminated with bright bands up to half an inch thick. The so-called "blue band" is locally as much as 8 inches thick, and is rarely less than 4 inches. Where this band is thick, the overlying band of bony coal is also thicker than the average. What is probably the same coal as this shows no shale band where it is mined half a mile to the north in a 20-foot shaft. About 4 miles to the east in sec. 14, a 24-inch bed was found at 165 feet, with sandy shale and sandstone overlying. The bed is full of bony layers, making it very hard to work; it carries an unusual amount of pyrite balls, lenses and stringers, and shows much calcium carbonate in facings.

From the few data available, it appears that the Colchester coal is developed over the north-central part of T. 5 N., R. 9 W., and in the southwest part of T. 6 N., R. 9 W., but that there is no marked uniformity in its deposition. It appears to have been deposited at the margin of the coal basin in more or less isolated patches, and under conditions which locally permitted the introduction of considerable amounts of mud, resulting in a carbonaceous bed about two feet thick which is workable in places.

North of Godfrey to the county line there is nothing to indicate the presence of any workable coal. At East Alton, the Tile and Sewer Pipe Plant has used the Colchester coal to a limited extent. The section exposed along the creek behind the plant is as follows:

Section exposed along creek behind the Tile and Sewer Pipe plant at East Alton

Description of strata	Thickness *Ft.*	 *In.*
Shale, sandy, buff colored, in thick beds	10	..
Shale, black fissile	2	..
Coal	2	6
Clay, gray, dark at top, lighter below	2	6
Limestone, somewhat bouldery but continuous, with fusulinas	1	6
Shale, light gray above, darker below	10+	..

The limestone of this section is apparently a distinct type. It is of medium gray color, slightly pinkish when fresh, weathering to buff. Fossils in this limestone are in the matrix rather than in fragments, and comprise crinoid rings, some small brachiopods and a small fusulina resembling *Girtyina ventricosa*. This has been considered the Colchester coal section, with the zone of the Cheltenham clay in the base underlying the "brecciated lime."

No other coal has been recognized in this area, and it is believed that even the Colchester coal is not sufficiently regular to be of consequence as a resource.

STRUCTURE

From present data, the Pennsylvanian strata appear to be involved in no major deformation. The results of detailed structural studies now in progress in this and adjoining areas will be presented in a forthcoming report on Madison County.

MASON COUNTY

INTRODUCTION

Although no coal has ever been mined in Mason County, it is known to be partly underlain by at least one bed of coal (Pl. I B). The following quotation from another publication of the Survey gives all available information on the coal and inferences as to its correlation:[19]

SURFICIAL DEPOSITS

"The coal-bearing rocks are deeply covered by glacial drift which in the hole at Mason City has a thickness of 204 feet. Its thickness in other places in the county is not known. Leverett says: 'The county occupies a low basin-like expansion of the Illinois valley, heavily covered with sand, except where the old river channels have left a surface deposit of muck.'[a]

COAL-BEARING ROCKS

"Except for information afforded by the drilling at Mason City, and for a general knowledge of conditions in surrounding counties, nothing is known concerning the coal which possibly underlies Mason County. In the drill hole a coal 34 inches thick was struck at a depth of 290 to 293 feet. This thickness of the coal suggests correlation with No. 2 rather than with one of the higher coals. Further evidence in support of this correlation is that No. 5 coal at Lincoln lies at about the same depth and latitude as the coal at Mason City, whereas by reason of the regional eastward dip, No. 5 coal should be considerably higher at Mason City than at Lincoln; in fact, high enough to bring it above erosion level beneath the drift.

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[19] Cady, G. H., Coal resources of District IV: Ill. Mining Investigations Bull. 26, p. 148, 1921.

[a] Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 688, 1899.

"It is probable, therefore, though by no means established, that if Mason City is underlain by coal, it is No. 2 rather than one of the higher beds, except in the eastern part of the county, where locally the drift may be thin and one of the higher coals, possibly No. 5, may be present in small areas."

McDONOUGH COUNTY

General Statement

McDonough County lies in the west margin of the Illinois coal field, and the geology of the "Coal Measures" is similar to that in the southern part of Warren County, and the western part of Fulton County (Pl. I A). It lies about 25 miles west of the recognized area of Belleville (No. 6) coal in eastern Fulton County. The Pennsylvanian rocks here are relatively flat-lying and extend to only shallow depths.

Production and Mines

The mine list for 1923 shows local mines operating in that year, but no shipping mines. The production was entirely from the Colchester (No. 2) coal.

Area underlain by workable coal	267 sq. mi.
Average thickness	24 inches
Amount available originally	604,700,000 tons
Production, year ending June 30, 1923	25,964 tons
Average annual production, 1919-1923	92,233 tons
Total production recorded	2,204,138 tons

Stratigraphy

PLEISTOCENE SYSTEM

The Pleistocene beds are for the most part level-topped, but lie on an uneven surface of bed rock. The surficial covering is loessial clay 5 to 10 feet thick, with clay, sand and small amounts of gravel below, making up a total of between 30 and 200 feet. This great range is due to the presence of buried valleys cut in the bed rock before the advent of the ice.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds are from 40 to 230 feet thick, and are known both from outcrops along the east fork of Crooked Creek along Camp and Grindstone creeks, and from drill logs and mining operations. A typical section compiled from these sources in T. 4 N., R. 3 W., is given as follows:

Typical Pennsylvanian section compiled from records of outcrops, borings, and mines in T. 4 N., R. 3 W.

Description of strata	Thickness	
	Ft.	*In.*
Sandstone, buff to gray, thin bedded	39	..
Shale, argillaceous, with ferruginous nodules	10	..
Coal (Colchester)	2	6
Clay and concealed beds	15	..
Shale, blue to white at top, drab below	9	..
Clay, sandy, bluish white	5	..
Sandstone, white, quartzose, thin-bedded, weathering to light buff	5	..
Interval, chiefly blue-black shale	20	..
Sandstone, white, quartzose, weathers to dark drab, contains partings of blue-black shale	4	..
Shale, in part very calcareous and filled with carbonized stems	3	..
Concealed, overlying Mississippian formations	6	..
Total	118	6

The Pennsylvanian includes parts of the Pottsville and Carbondale formations. The Pottsville, 125 feet thick, comprises thin sandstones and shale, with one to three thin coals and one limestone. The limestone is an important stratigraphic marker in this region and is described in the Colchester-Macomb folio[20] as follows:

> "The limestone is bluish gray, fine grained and very brecciated or nodular, so that it weathers with a characteristically uneven surface. It has no regular bedding or cleavage. In its brecciation, texture, and general aspect it somewhat resembles the St. Louis limestone, but can be discriminated from it by the nature of contiguous beds. In places it contains many crystals of marcasite or pyrite, which on weathering give it a reddish tinge......... In some outcrops it is a continuous ledge rarely as much as 5 feet thick; in still others it is represented only by rows of 'boulders' in clay, or by inconspicuous calcareous shale, and in still others it is altogether wanting."

McDonough County appears to be uniformly underlain by beds of the Pottsville formation, which show considerable lithologic variation from place to place. The Carbondale formation, which has a maximum thickness of 90 feet, comprises sandstones, shales, one coal, and one limestone. Irregular patches of the Carbondale are found extending northward from Colchester and Good Hope, and in the southern part near Industry. The two important members of this formation are the coal bed known as the Colchester or No. 2 coal, which lies at the base of the formation, and the Vergennes sandstone which appears at the top of the formation over an erosion unconformity of marked irregularity. This sandstone was called the Vergennes by Hinds[21] because of its resemblance to a sandstone of similar position, so named by Shaw in the Murphysboro quadrangle.

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[20] Hinds, Henry, U. S. Geological Survey Geol. Atlas, Colchester-Macomb Folio (No. 208) p. 6, 1919.

The coals of the Pottsville show an irregular deposition which is apparently original. Where but one prominent coal appears it is usually called No. 1. It is not to be understood, however, that the No. 1 of one locality is positively known to be the stratigraphic equivalent of the No. 1 of other localities. The main coal of the Pottsville lies between 30 and 40 feet below the Colchester coal. The Colchester (No. 2) coal is relatively widespread, and presumably appears in fairly uniform thickness (20 to 30 inches) over the northern part of the county and in isolated patches in the southern part, as indicated by the line of outcrop on the map (Pl. I A). Above the coal is blue shale which reaches a maximum thickness of 55 feet. The beds are much more sandy at the top where the greater thicknesses are exposed. Below the Vergennes sandstone in places there appears a thin limestone which is quite fossiliferous. This lies from 25 to 30 feet over the Colchester coal.

Most of the logs record only shallow drillings, a large number reaching only the Colchester coal. Typical of the deeper logs is that from the farm of W. H. Young in sec. 9, T. 7 N., R. 2 W. (Walnut Grove Twp.):

Record of well drilled on W. H. Young farm, sec. 9, T. 7 N., R. 2 W.

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene system	..	..	...	..
Soil	10	..	10	..
Sand	2	6	12	6
Pennsylvanian system	..	..	...	..
Soapstone	4	..	16	6
"Slate" and rock	3	6	20	..
Soapstone	18	3	38	3
Coal Colchester (No. 2)	2	..	40	3
Fire clay, very white	6	3	46	6
Clay, hard, or rock	7	..	53	6
Soapstone, hard	5	..	58	6
Rock	4	6	63	..
Soapstone, hard	13	..	76	..
Clay, hard	1	6	77	6
"Slate"	1	6	79	..
Fire clay	5	..	84	..

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[21] Hinds, Henry, U. S. Geological Survey Geol. Atlas, Colchester-Macomb Folio (No. 208) p. 6, 1919.

Record of well drilled on W. H. Young farm, sec. 9, T. 7 N., R. 2 W.
—Concluded

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
"Slate", hard	14	..	98	..
Soapstone	5	..	103	..
"Slate"	7	..	110	..
Shale rock	4	6	114	6
"Slate" and rock	4	6	119	..
Fire clay	2	6	121	6
Rock, hard	3	3	124	9
Fire clay	1	6	126	3
Rock, very hard (could not drill through it)	8	6	134	9

Although the "hard soapstone" of this section is probably a sandy shale, the absence of true sandstone is notable. The Pennsylvanian beds lie in marked unconformity on the Mississippian formations. The relief of this old rock surface is probably in excess of 100 feet.

STRUCTURE

The Pennsylvanian beds are essentially flat-lying, the Colchester coal ranging from about 640 feet to nearly 700 feet above sea level. So far as available data from mining operations indicate, the Pennsylvanian in this county is free from minor structure such as slips, small faults, and rolls which commonly interrupt the continuity of the coal elsewhere.

COLCHESTER COAL

The main coal of the county is the Colchester (No. 2) commonly mined by drifts or shallow shafts, and which, because of its thinness (about 24 inches) is not mined on a commercial basis except in connection with some of the clay plants. The coal is of good quality, however, and shows no persistent partings or impurities. In places it carries a few lenses and small nodules of iron pyrites ("sulphur"), films of mother coal, calcite, and gypsum, and streaks of bone an inch or less thick. It is jet black, with some bands of dull luster, has a hackly fracture and shows no well developed cleat or horizontal cleavage. The bed is thus exceptionally clean and is relatively undisturbed by horsebacks, clay slips, or rolls. The most important coal area is about Colchester, and the next most important is in the south-central part of the county where but little mining has been done up to the present time. The roof of the coal is in all cases a blue-gray shale, somewhat massive and in places quite sandy, which serves well for mining purposes. Below the coal is an underclay a little more than 2 feet thick, which in most places is soft and plastic and makes an ideal medium for undercutting the coal.

Other Coal Beds

No other coal beds are mined except for private uses in those localities where the Colchester coal is absent, and one of the Pottsville coals is developed in thickness sufficient to make small mining practical. These are not considered of sufficient value to be included in an estimate of the resources of the county.

MERCER COUNTY

General Statement

Mercer County lies in the northwestern part of the State, having approximately the same relation to the Illinois coal field as Rock Island County (Pl. I A). The "Coal Measures" in the northeastern part of the county are continuous with those of Rock Island on the north and Henry on the east. Farther west the Pennsylvanian beds are thin, and near Seaton, in the southwestern part of the county, they have been eroded and Mississippian beds lie at the surface.

Production and Mines

Mining is somewhat more active in Mercer than in Rock Island County, the 1923 report of the Department of Mines and Minerals listing 15 local but no shipping mines. This is a larger number than has been reported for some years, and reflects the recent coal shortage.

Area underlain by workable coal	127 sq. mi.
Average thickness	34 inches
Amount available originally	412,130,000 tons
Production, year ending June 30, 1923	39,275 tons
Average annual production, 1919-1923	875,230 tons
Total production recorded	13,689,352 tons

Stratigraphy

PLEISTOCENE SYSTEM

Outcrops of the coal-bearing rocks are rare, for the county as a whole is deeply mantled with glacial drift. These surficial deposits range in thickness from a few feet in stream valleys to more than 200 feet beneath some of the upland.

PENNSYLVANIAN SYSTEM

Practically all data regarding the extent and character of the Pennsylvanian rocks are gained from mines and drill logs. The latter are mainly from east of Aledo and are closely spaced in the Matherville area, but widely scattered elsewhere. The Pennsylvanian ranges in thickness from less than 75 feet to as much as 150 feet. Few logs are at hand in which the precise base of the system can be determined, but present data indicate maximum thickness of Pennsylvanian at the east margin of the county. At the west, near the boundary of the "Coal Measures" the thickness is probably considerably less than 75 feet, but there are no logs showing this westward thinning.

So far as appears in the well logs, the Pennsylvanian section is predominantly shale, most of the sandstone appearing in the upper part. The following log is typical of the barren beds in Mercer County, but cannot be considered as a generalized section:

Log of boring showing typical Pennsylvanian succession of the barren beds in Mercer County

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene system				
Soil and clay	23	..	23	..
Drift, gray	19	..	42	..
Sandy clay	7	..	49	..
Drift, gray	16	..	65	..
Pennsylvanian system				
Soapstone	2	..	67	..
Shale, red	3	..	70	..
Sandy rock	1	..	71	..
Soapstone	8	..	79	..
Shale, light	5	..	84	..
Sand rock, gray	10	..	94	..
"Slate", dark	2	..	96	..
Sand rock, gray	3	..	99	..
"Slate", dark	17	..	116	..
Shale, light	7	..	123	..
"Slate", black	14	..	137	..
Coal	..	3	137	3
Fire clay	4	9	142	..
"Slate", gray	36	..	178	..
Sandstone, light	3	..	181	..
"Slate", black	3	..	184	..
"Slate", black	10	..	194	..
Sand rock, light	2	..	196	..

Log of boring showing typical Pennsylvanian succession of the barren beds in Mercer County—Concluded

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Mississippian system				
Shale, light	24	..	220	..
Shale, blue	6	..	226	..
Shale, light	5	..	231	..
Lime shale	58	..	289	..
Shale, brown	2	..	291	..
Lime shale	5	..	296	..

Of the above section, the first four beds are surficial, the next lower members to a depth of 196 feet are probably Pennsylvanian, and the rest of the section should perhaps be referred to the Mississippian.

A section typical of the coal-bearing part of the system is added below for comparison:

Log of test boring in the town of Cable

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene and Recent systems				
Soil and clay	9	..	9	..
Pennsylvanian system				
Pottsville formation				
Sandstone and shale	3	..	12	..
Limestone, blue, shaly	9	..	21	..
Coal	3	6	24	6
Underclay and shale	57	..	81	6
Sandstone	30	..	111	6
Coal	2	6	114	..
Underclay and shale	12	..	126	..
Devonian system				
Limestone	52	..	178	..

But one stratum reported in this log is recognizable over much of the county. This is the blue, argillaceous limestone overlying the thicker coal. This and the coal itself are probably correctly identified at Sherrard, Matherville, in the area north of Millersburg, and southward nearly to Burgess. The limestone carries fossils, locally abundant, among which is the small protozoan Fusulina, which has not been found in this county except at this horizon.

The Rock Island coal is the only one of commercial value and it has an irregular distribution. Another coal which has been worked to a limited extent lies from 15 to 30 feet below the main bed. This is even less uniform in character and distribution than the main coal. Throughout much of the area in which the Rock Island coal can be profitably worked, drill logs record the presence of a thin coal lying 10 to 25 feet over the main bed.

Little is known of the character of the pre-Pennsylvanian surface. It seems probable that it closely resembles that of Rock Island County in showing considerable relief. Study of the available logs indicates that in the southern part, at least, the "Coal Measures" are underlain by Mississippian rather than Devonian beds.

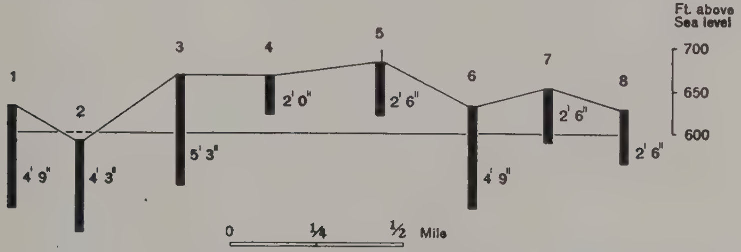

FIG. 8. Diagram showing relation of thickness of the Rock Island coal to its altitude. Except in No. 3, which may be structurally high, the thicker coal lies in the hollows.

T. 15 N., R. 2 W.
1. SE. ¼ SE. ¼ sec. 27.
2. SE. ¼ SE. ¼ sec. 27.
3. NE. ¼ SE. ¼ sec. 27.
4. SE. ¼ NE. ¼ sec. 27.

T. 15 N., R. 2 W.
5. SE. ¼ SE. ¼ sec. 22.
6. NE. ¼ SE. ¼ sec. 22.
7. NW. ¼ SW. ¼ sec. 23.
8. SW. ¼ NW. ¼ sec. 23.

STRUCTURE

The Pennsylvanian beds are flat-lying over the county as a whole, although they are affected by minor flexures which give rise to sharp local folds. The one recognizable bed in the series, the fossiliferous limestone, shows a remarkably flat attitude except for these minor deformations. This bed lies at an elevation of 670 feet north of Millersburg and is only five feet lower near Cable, 15 miles to the east. In the intervening area, local warping has produced many times this amount of relief, in one instance 90 feet being measured in less than a mile. In general, the coal is thicker in the low places and thinner where it lies at a greater elevation. This is illustrated by figure 8, in which the top elevation of the coal and the thickness of the bed at each point are indicated. These relations are exhibited in all three of the districts in which mining has permitted detailed observation. While the data available from the Sherrard mine are not full enough to make the point clear, there is some indication that the coal there worked lies in a trough with relatively steep sides.

At Cable the situation is better known. The coal lies in a basin-shaped depression, the center of which is just north of the village. In the mines north and northwest of Cable, the coal lies at an elevation of about 602 feet above sea level. Less than a mile southwest the elevation is 650 feet and the coal scarcely half as thick.

Similarly at Matherville, most of the thick coal lies in a troughlike depression. In Alden No. 7 mine, the coal surface was about 590 feet above sea level at the shaft, but varied from this throughout the workings. Less than a mile southwest, the coal outcrops at an elevation of 650 feet, and the coal is thin.

The fact that the coal is almost uniformly thicker in the hollows than on the "hills" of the mines suggests that the variation in altitude is at least in part original in the coal, reflecting the irregularities of the surface on which the bed was deposited. On the other hand, the fact that in some of the depressions the cap limestone shows essentially the same amount of relief suggests that the unevenness is in part due to deformation of the strata after the deposition of the whole series.

Rock Island Coal

The most important coal of the county is the Rock Island bed. While fairly widespread in the eastern portion of the county this bed shows a very uneven deposition and coal of workable thickness has a distinctly patchy distribution. The known areas of thicker coal lie in Tps. 14 and 15 N. of Rs. 1, 2, 3, and 4 W. It is probable that small areas of equally thick coal lie in the vicinity of the areas mapped. Present information does not warrant an attempt to include them in the estimates of total coal area and tonnage for the county.

Within the mapped areas the coal probably has an average thickness of 40 inches or more. The coal ranges from 24 to 60 inches in thickness where it is worked. Outside of the mapped areas, and particularly in the western part of the county, the coal is uniformly thinner.

In places this coal bed appears to be split by a band of shale. Such an occurrence is reported by Green[22] from the southeast quarter of section 1, T. 14 N., R. 3 W., where the coal showed an 8-inch parting in the middle. While this parting was reported from only a few mines, and was generally quite thin, a short distance east of this locality it was 20 inches thick and to the west it was reported as much as 4 feet.

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[22] Green, H. A., Geol. Surv. of Ill., Vol. IV, p. 305, 1870.

The following notes on the character of the coal are taken from a report on the Milan quadrangle[23]:

"In the mines where the coal bed has been worked, the thickness varies from 2½ to nearly 5 feet. It is a black, and rather soft coal, having a dark-brown streak. Where it is normally developed it is in a single bed which contains a parting with some impurities a short distance below the middle part. The details of this coal and associated strata at different localities where the bed could be well studied are shown below:

Section of coal in mine No. 3 of Coal Valley Mining Company at Matherville

	Thickness *Feet*
Limestone, dark	7+
Shale, black, fissile, fossiliferous	¼
Coal, with much mineral charcoal in thin bands, and showing indistinct impressions of leaves and other parts of plants. Sulphur occurs disseminated in chunks or small particles in the lower part of the coal, and in thin leaf-like layers in the upper	3½ to 5

Section of coal bed in mine No. 7 of the Alden Coal Company at Matherville

		Thickness	
		Ft.	*In.*
Limestone, dark		7+	..
Shale, dark		3	2
Coal	upper bench	1	4
	middle bench	..	10
	lower bench, with a little marcasite near the top	2	6
Shale, with marcasite and imprints of *Stigmaria*		1	..
Underclay		3	6

Section of the coal in the mine of Dougherty Bros., near Boden

	Thickness	
	Ft.	*In.*
Limestone, dark	14	..
Shale, black, fissile	2	..
Coal	2	10
Shale, or bony coal, brown, containing marcasite	..	2
Underclay, gray	2+	..

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[23] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Ill. State Geol. Survey Bull. 38, p. 195, 1921.

The following data are taken from mine notes made by various members of the Survey:

Coal Valley Mining Company No. 2 mine at Sherrard

Entrance: shaft, about 210 feet to coal, Rock Island bed.

Thickness of rock over coal: 75 feet.

Roof: limestone in general, but with intervening slate up to 10 feet in places.

Coal: maximum 54 inches, minimum 36 inches, average 42 inches. Occurs in two benches, the top being harder and brighter. In places the bottom has numerous bony bands.

Floor: underclay at least five feet thick; in places the clay is separated from the coal by a bony layer, a thin sandstone, or a hard carbonaceous shale known as "false bottom." When wet, the clay interferes with mining by heaving. In places it goes to the roof.

Throughout most of the mines the coal is affected by slips, small faults, and by rolls. These are of little consequence in mining operations. A typical fault is shown in figure 9.

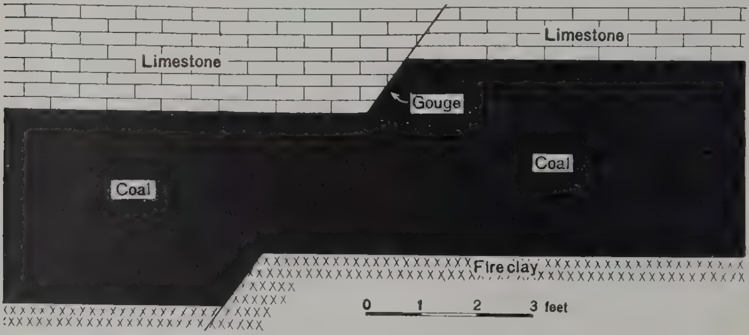

FIG. 9. Sketch of fault in Sherrard mine, Mercer County.

Coal Valley Mining Company No. 3 mine at Matherville

Entrance: shaft about 65 feet to coal; Rock Island bed.

Thickness of rock over coal: 34 feet.

Roof: limestone with intervening "slate" up to 8 feet.

Coal: maximum 60 inches, minimum 44 inches, average 54 inches. Two benches, the upper harder and in places brighter than the lower. Partings of sulphur not abundant; more sulphur in plates along joints and crevices. In places the bed shows a very large amount of "mother coal" filled with impressions of plants and showing a charred woody structure. This material occurs in layers and lenses which are locally cemented into hard masses by sulphur.

Floor: underclay, probably several feet thick, light gray, sandy; shows plant impressions. Below the clay is a sandstone which has been penetrated as much as 20 feet. This bed is in contact with the coal in places. (Note: It may be questioned whether this sandstone is not identical with one reported from the No. 2 Mine at Sherrard, which was reported there to overlie the clay.)

Variations in the thickness and position of the coal are common.

Alden Coal Company No. 7 mine at Matherville.

Entrance: shaft about 90 feet to coal, Rock Island bed.
Thickness of rock over coal: not measured.
Roof: limestone with as much as three feet of black slate over coal locally.
Coal: maximum 57 inches, minimum 45 inches, average 54 inches. Uniformly in two benches, separated by a smut band. Considerable calcite throughout the coal. Sulphur in thin veinlets in the bed.

Other Coal Beds

In the southeastern part of Mercer County is an area of a few square miles underlain by a coal lying above the Colchester (No. 2) coal. This is an extension of the Soperville field in Knox and Warren counties and it is not well known in Mercer County. The coal probably averages about 40 inches in thickness and has about the same character and associated beds as in the adjoining region. Details for Mercer County are lacking and the reader is referred to the discussion of this bed in Knox County for such data as are available.

Small areas of thin coal are known to lie in T. 13 N., R. 2 W., in T. 14 N., R. 1 W., and possibly in the extreme western portion of the county, T. 15 N., R. 5 W. Most of these beds are less than 18 inches in thickness and are not considered of commercial importance.

MORGAN COUNTY

General Statement

Morgan County lies near the middle of the east border of District III, and beds of early Pennsylvanian age come to the surface in the western part of the county near Neelys (Pl. I B). It bears much the same relation to the main Illinois field as do those counties farther north like McDonough and Warren, which have a border of Mississippian rocks on the west, and of late Pennsylvanian rocks on the east.

PRODUCTION AND MINES

In 1922 the report of the Department of Mines and Minerals listed but three mines producing a total of less than 1,000 tons. The report for 1923 shows but one operating mine producing 400 tons.

Area underlain by workable coal	533 sq. mi.
Average thickness	27 inches
Amount available originally	1,340,500,000 tons
Production, year ending June 30, 1923	400 tons
Average annual production, 1919-1923	2,810 tons
Total production recorded	83,219 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The covering of Pleistocene over the bed rock is relatively thick, averaging about 40 feet. Boulder clay with considerable thickness of sand and gravel is reported in drill logs. A surficial loessial clay covers much of the county, and is particularly thick in the western part near the Illinois.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds are relatively thin in the western part of the county, but eastward from the vicinity of Jacksonville reach thicknesses in excess of 150 feet. There are practically no outcrops in the western part of the county, and what information is available comes from the coal and oil tests which have been made. The details of the columnar section are by no means well known, and as a result, correlations within the county are difficult, and between Morgan and adjoining counties impossible. A typical log follows:

Log of boring at Jacksonville

Description of strata	Thickness *Feet*	Depth *Feet*
Soil and drift	94	94
Shale, bluish gray	58	152
Coal	3	155
Fire clay	3	158
Shale, mixed, yellow and blue	62	220
Limestone, Mississippian	..	...

It is not improbable that some of the shale overlying the Mississippian limestone really belongs with the Mississippian formation, reducing the thickness of the Pennsylvanian by that much. The log of a shaft from a mine in section 9 of T. 14 N., R. 10 W. is as follows:

Log of shaft from mine in sec. 9, T. 14 N., R. 10 W.

Description of strata	Thickness	
	Ft.	*In.*
Soil and drift	29±	..
Limestone	5	..
Shale, gray, "soapstone"	16	..
Shale, black, fissile ("slate")	3	..
Coal, with one or two partings	3	4
Clay, base not exposed	2	..

In the western part of the county, in the vicinity of Neelys, the following section is exposed in the stream south of the Wabash Railroad:

Section of Pennsylvanian strata exposed near Neelys

Description of strata	Thickness
	Feet
Surface	2
Coal, much weathered, with a 2-inch clay band one foot above the base	4
Clay, light to medium gray, slightly gritty, base unexposed	3

This coal is reported to lie 40 feet above the coal which was formerly mined here.

STRUCTURE

Very little is known of the structure of the Pennsylvanian beds in Morgan County. This is partly due to the lack of data as to the altitude of any given bed in the section over the county, but also due to the impossibility of correlating the coal beds in the different parts of the county. Thus the relation between the Jacksonville and Neelys coals is not known, and the general structure for the two areas cannot be determined.

From the limited data in the western part of the county, the Pennsylvanian beds appear to be flat-lying except for the usual local variations common to "patchy" fields. For the Jacksonville area somewhat more careful studies have been made in connection with oil studies and the following paragraph is taken from a recent report on that field.[24]

> "A detailed contouring of the Pennsylvanian structure or folding based on the correlation of a certain coal which has been reported rather frequently in logs of wells in the vicinity of this particular area has been attempted. Contours are drawn on this coal, but they can be considered as

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[24] Collingwood, D. M., Oil and gas development in the vicinity of Jacksonville: Ill. State Geol. Survey Bull. 44, p. 20, 1923.

tentative only. Not only were the logs scarce and imperfectly kept, but some wells were not close enough together to enable exact correlation, and as it was not possible to run levels to all of these holes in the limited time available, in some cases the elevations had to be estimated from comparison with railroad levels."

JACKSONVILLE COAL

One of the two areas in which mining has been carried on in western Morgan County lies about five miles south of Jacksonville. Little is known of the area underlain by this coal, but it probably extends as far south as Woodson and the scattered drill records indicate that it may extend beyond the south limit of the county. It is possibly of commercial thickness to within 2 miles of Jacksonville, but may not be important beyond that point. From records apparently reliable this bed ranges from 36 to 72 inches in thickness. An average thickness is probably about 42 inches. The roof is black "slate" beneath limestone cap-rock, and gives little trouble in mining. The floor is fire clay about 8 feet thick.

NEELYS COAL

Coal has been found and mined at several places in Tps. 15 and 16 N., R. 12 W. While precise correlation between the several occurrences has not been made, most of the beds have been tentatively classed as belonging to the zone of the Colchester coal. The coal at Neelys was one of the earliest to be worked, and hence the name is in common use. This bed is not definitely known to underlie any extensive area in the county, but may fairly be assumed to be present throughout the county east of Neelys.

It has an average thickness of about 24 inches, ranging from 20 to 54 inches where worked. It is reported to be of good quality, although commonly carrying considerable sulphur in the form of iron pyrites. The gray shale and black fissile shale roof commonly over this coal is absent at Neelys, where glacial drift comes down to the coal, necessitating considerable loss of coal as some had to be left up for roof. The floor is of gray clay, commonly showing remains of plant fossils.

CONFUSION IN CORRELATION

In the early reports on the coal of this county some of the beds were referred to the Rock Island (No. 1) of the Fulton County section, others to the Colchester (No. 2), and still others to No. 3. From available data it is not clear that these correlations are justified, nor indeed that all three coals are present. Two coals are present at

Neelys, one below drainage, known as the Neelys coal, and another, also four feet thick, lying about 40 feet above it. The latter has a shale parting below the middle and is not recognized elsewhere in the county.

Two coals were reported from the southwest part of T. 16 N., R. 2 W., but it is possible that a difference in elevation of two coal beds worked gave the impression of a difference in stratigraphic position.

PIKE COUNTY

General Statement

Pike County lies on the southwest margin of the coal basin and has an even thinner cover of "Coal Measures" than Adams and Brown counties to the north (Pl. I B). The area is dissected by streams in the same way, giving a very irregular areal pattern with numerous isolated patches outside the main Pennsylvanian field. This entire field is separated by the Illinois from the coal area of Cass, Morgan, and Macoupin counties.

Production and Mines

Pike County does not appear in the list of producers published by the Department of Mines and Minerals. There has been from time to time, particularly in the early days, some exploitation of such beds as appear in the county. The opening of transportation across Illinois River made the thicker coal in those counties to the east accessible, and very little mining has been done since.

Area underlain by workable coal	85 sq. mi.
Average thickness	24 inches
Amount available originally	193,000,000 tons

Stratigraphy

pleistocene system

The Pleistocene is of the same character as appears in adjoining counties, although it is not especially thick in that portion of Pike County underlain by coal-bearing rocks. A top covering of loess from 5 to 10 feet is usually present. This deposit reaches thicknesses of nearly 70 feet in the bluffs at Chambersburg. The underlying drift, comprising the usual boulder clay with small amounts of sand and gravel, averages probably less than 30 feet thick.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds outcrop on the west margin of the coal field in the vicinity of Hadley and along the east margin from Maysville to the northern boundary of the county. Very few logs are available which indicate the character of the Pennsylvanian beds, although there has been considerable deep drilling showing the lower strata. The Pennsylvanian beds probably do not exceed 60 feet in thickness, and the greater thicknesses are in the northern part of the county. Toward the south, the coal-bearing beds thin to a feather edge.

Several outliers in the vicinity of Pittsfield have produced small amounts of coal. The coal is mainly the Colchester bed and above it, in many places separated by a few feet of gray shale, is a black fissile shale which appears to accompany this bed throughout this part of the Illinois basin. One other stratum of importance is a dark gray shale, highly calcareous, which contains great numbers of small brachiopod shells, among which *Marginifera muricatus* and *Chonetes mesolobus* are predominant. A typical section for the northern part of the county is as follows:

Typical Pennsylvanian section for northern Pike County

Description of strata	Thickness	
	Ft.	*In.*
Drift	18	..
Shale, light gray to blue, very sandy near the top	45	..
Shale, medium to dark gray, with large argillaceous limestone nodules in a zone near the middle "Chonetes bed"	6	..
Shale, black fissile and coal, soft, highly weathered	1	2
Clay, medium gray, slightly gritty	2	..
Clay, white to light gray, abundant gypsum crystals, base unexposed	3	..

A typical section for the vicinity of Maysville includes:

Typical Pennsylvanian section near Maysville

Description of strata	Thickness	
	Ft.	*In.*
Drift	30	..
Shale, medium to dark gray "Chonetes bed"	3	..
Shale, dark gray, flaky, weathers blue	..	5
Shale, black fissile	..	10
Coal, highly weathered	1	7
Clay, white to gray, gypsum crystals	16	..
Sandstone, white, thin bedded	2	..
Shale, base unexposed	1	..
Interval	8	..
Limestone, cherty Mississippian	..	..

The section for one of the outliers near Pittsfield includes:

Pennsylvanian section near Pittsfield

Description of strata	Thickness Ft.	In.
Loess and drift	98	..
"Slate", black	4	..
Coal	1	..
Clay, gray	..	4
Flint rock and limestone, Mississippian	..	..

It is apparent from the inspection of these sections that the thicker "Coal Measures" in the north include Upper Pennsylvanian beds which do not appear at the south end of the field.

In the northern part of the county, the Pennsylvanian beds lie on the Salem limestone, but elsewhere on the Burlington limestone showing an unconformity on the Mississippian beds which was brought about by an uplift of those strata, followed by erosion of the upper portion of it in pre-Pennsylvanian times. The surface below the Pennsylvanian does not have as great relief as appears farther north.

STRUCTURE

Very little information regarding the structure of these beds is available, although a low northeasterly dip brings the Colchester (No. 2) coal from 650 feet above sea level on the east margin to about 720 or 740 feet on the west. Minor warping of these beds has not been worked out in sufficient detail for presentation, but it is believed to be unimportant in mining.

COLCHESTER COAL

Most of Tps. 3 and 4 S., R. 4 W., as well as additional areas on the east and west as mapped, are underlain by the Colchester (No. 2) coal. Some of the small outliers also contain coal. No bed, other than the Colchester, has ever been found, and even it is of such thickness as to make extraction expensive, except by the method of stripping where the overburden is light. In such situation, the lack of cover may have resulted in some weathering of the coal, thereby appreciably lessening its value. The coal is rarely more than 20 inches thick, averaging less than 18 inches.

In sec. 10, T. 4 S., R. 5 W., is a very limited area of coal which reaches a maximum of 6 feet. The character of the bed, together with its roof and floor suggest it is Colchester coal which here is filling a depression in the Mississippian limestone, and hence reaches an unusual thickness. Throughout the Pike County field, the roof is gray shale, with an overlying black fissile shale or "slate", the gray shale ranging from half an inch to several feet in thickness. The floor is unconsolidated gray clay, which is locally sandy.

ROCK ISLAND COUNTY

General Statement

Rock Island County lies at the northwest margin of the Illinois coal basin; consequently the beds of the Pennsylvanian or "Coal Measures" underlying most of the county give place in the northern portion to rocks of Devonian and Silurian age (Pl. I A). These latter are exposed in places along both Mississippi and Rock rivers and their tributaries in that part of the county lying northeast of Andalusia and Milan, in Tps. 17, 18, 19, and 20 N., Rs. 1 and 2 E. and Rs. 1, 2, and 3 W.

Production and Mines

No shipping mines are now operated in the county. The small production recorded comes from a few country banks. The report of the State Mine Inspector for the fiscal year 1923 gave nine local mines having a total production of 63,035 tons.

Area underlain by workable coal	63 sq. mi.
Average thickness	29 inches
Amount available originally	171,760,000 tons
Production, year ending June 30, 1923	63,035 tons
Average annual production, 1919-1923	326,334 tons
Total production recorded	3,098,876 tons

Stratigraphy

PLEISTOCENE SYSTEM

The beds of the "Coal Measures" outcrop along stream channels in places, but for the most part are concealed beneath surficial materials which here have a maximum thickness of over 200 feet. These consist of clay, sand and gravel of glacial origin, together with loess, terrace deposits, river alluvium, and dune sands.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds lie unconformably on Devonian or Silurian strata. The exposures near Rock Island show the basal Pennsylvanian beds to be sandstone and conglomerate with lesser amounts of shale. Near Black Hawk's Watch Tower across Rock River from

Milan are several exposures showing Pennsylvanian beds rising over protuberant Devonian limestone (fig. 10). The pre-Pennsylvanian surface was rather uneven, and resulted in irregular and patchy deposition of early Pennsylvanian strata. Worthen[25] found 60 to 70 feet difference in elevation in a coal bed in less than a mile near Hampton, and assumed the irregularity to be conformable with the surface of the underlying limestone.

Drilling has been concentrated on relatively small areas, so that there is little or no data available as to geologic conditions over most of the county. From the outcrops, from the various openings on the coal and from a study of drilling records at hand, the main features of the Pennsylvanian beds can be learned.

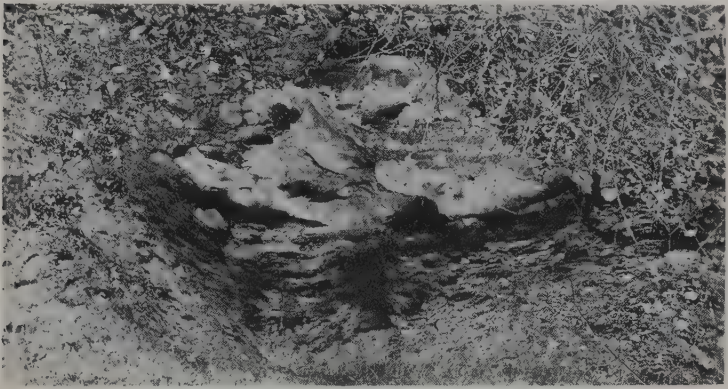

Fig. 10. Pennsylvanian shaly sandstone over protuberant Devonian limestone. Near Black Hawk's Watch Tower, Rock Island County.

The extreme northeastern margin of these strata lies between Port Byron and Rapids City. From south of Hampton to East Moline no Pennsylvanian beds are known, but from East Moline south and west to the bluffs opposite Muscatine, Iowa, the county is nearly all underlain by rocks of the "Coal Measures". The strata are not identical in character from place to place and have few fossils which serve to identify them, yet by means of the lithologic character, fossils, and structural relations, their stratigraphic relations can be approximately determined.

The Pennsylvanian beds are thin at the northeast, ranging from a feather edge near Port Byron to nearly 100 feet southeast of Hampton. Greater thicknesses are met to the south and west reaching a maximum of about 250 feet in Buffalo Prairie Township (T. 16 N., R. 4 W.).

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[25] Worthen, A. H., and Shaw, James, Geol. Surv. of Ill. Vol. V, p. 220, 1873.

In the northeast part of the county, the Pennsylvanian rocks are mainly sandstone. Over the coal in the mines east of Hampton is a thin argillaceous limestone, some shale, and an upper sandstone with flint beds, with an underclay and some shale between the coal and the pre-Pennsylvanian limestones. The coal bed itself occupies only two small basins, one near Rapids City and one two miles from Hampton. Drilling shows the latter to lie beneath parts of secs. 15, 16, and 22 of T. 18 N., R. 1 E. The northern basin is probably of even smaller size.

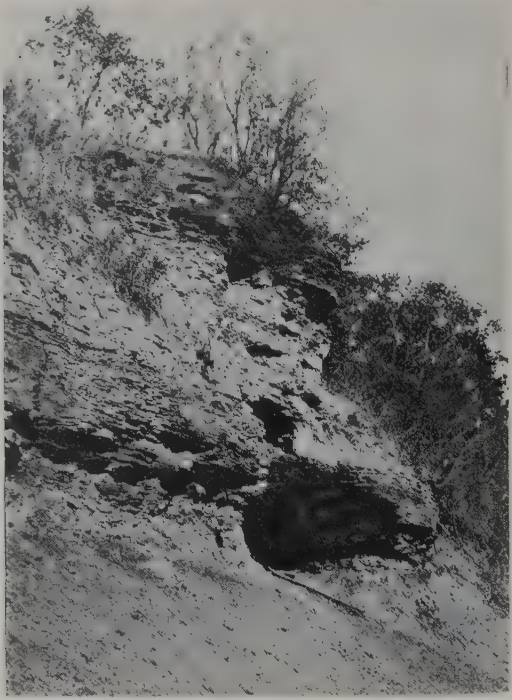

Fig. 11. Abandoned drift in Rock Island coal showing overlying beds and 10 feet of fossiliferous shale below, sec. 9, T. 19 N., R. 1 E., Rock Island County.

The Pennsylvanian beds in the Carbon Cliff area (fig. 11) are in part like those at the northeast, but include other beds which appear to lie below the coal section. These latter include the dark carbonaceous shale now being worked at the Tri-City Brick Company's pit.

In the Coal Valley area the same beds appear in outcrop and mines as at Carbon Cliff, with some 60 feet of beds below the coal worked there.

To the west, near Andalusia, the Pennsylvanian rocks are exposed in valleys tributary to the Mississippi. Here the following section was reported by Savage[26]:

Exposure of Pennsylvanian strata near Andalusia

Description of strata	Thickness Ft.	Thickness In.
McLeansboro formation		
Sandstone, thin bedded, gray to yellow, micaceous	12	...
Shale, gray, sandy, in layers 1 to 6 inches thick, with bands of sandstone and thin clay-ironstone concretions	25	...
Coal (locally present)	..	6
Shale, gray	4	...
Limestone, concretionary, argillaceous (locally absent)	1 to 4	...
Carbondale formation		
Coal, (Herrin, No. 6 bed?): locally present	4 to 11	...
Pottsville formation		
Sandstone, thin-bedded	4	6
Coal (locally present)	1	1½
Shale, gray to dark, with many small concretions of clay-ironstone	13	...
Coal (locally present)	½ to 1½	...
Sandstone, gray, micaceous, in thin layers, with a thicker layer at the top	3	6
Shale, gray to black, the middle part with large concretions and bands of dark nodular limestone, the surfaces of which are covered with "cone-in-cone" structures, and in places nodules covered with pisolite	21	...
Sandstone, hard, quartzitic, in two layers	1	6
Coal, in some places	½ to 2	...
Shale, gray to dark	23	...

To the south, in Buffalo Prairie Township (T. 16 N., R. 4 W.), a greater thickness of Pennsylvanian beds appears. No recognizable horizon is noted in logs from this area but the relative elevation of the Rock Island coal and the beds recorded suggest that the Pennsylvanian here may extend as much as 150 feet below the zone of that coal. In the extreme western part of the county the upper part of the Pennsylvanian section consists of sandy beds, locally 60 feet thick.[27] These appear to belong to the upper part of the Pennsylvanian system.

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[26] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Ill. State Geol. Survey Bull. 38, p. 149, 1922.

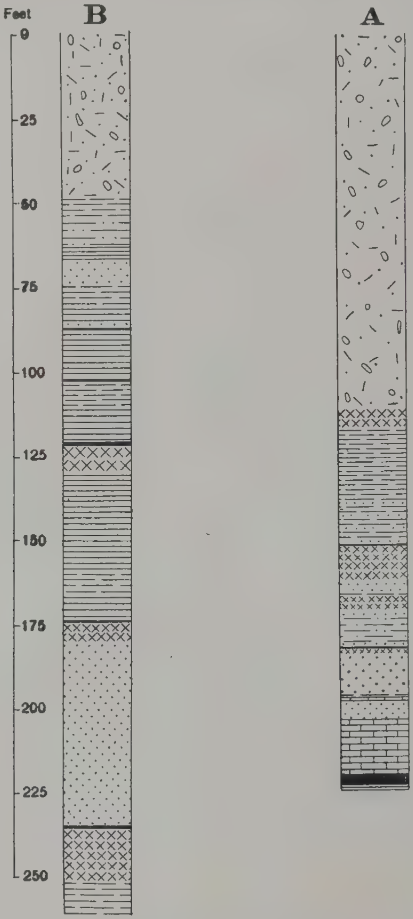

FIG. 12. Graphic logs from eastern and western parts of Rock Island County. A. Eastern part. B. Western part.

Two formations of the county merit special notice because of their stratigraphic importance. These are the limestone, which locally is the cap-rock of the Rock Island coal, and the massive sandstone near the top of the section exposed near Muscatine, Iowa.

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[27] Savage, T. E. and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Ill. State Geol. Survey Bull. 38, p. 152, 1922.

The coals of the county are distributed irregularly, are of variable thickness, and appear at different horizons in the Pennsylvanian section. Typical logs from the eastern and western parts of the county are presented for comparison (fig. 12). The lack of adequate records for the eastern part has necessitated the substitution of a log from just south of the county line in Mercer County.

The most important coal of the county is the Rock Island coal which has been worked at Coal Valley, Carbon Cliff, and Hampton. Other coals appear above or below this coal, but they seem to have a still more limited development. In no case has any thicker coal been discovered, nor one with wider or more uniform development. Thin coals have been reported from near the base of the "Coal Measures" but these apparently have no commercial value.

STRUCTURE

The base of the Pennsylvanian beds in Rock Island County has an altitude ranging from about 600 feet near Milan to about 475 feet near Buffalo Prairie. The upper surface of the Pennsylvanian beds ranges from about 560 to over 730 feet. Since no single stratum or group of strata have been recognized throughout the county, it is not possible to determine the structure of the beds as a whole. Comparison of the elevations of the two formations above noted leads to the inference that at least the upper Pennsylvanian beds lie essentially flat, and there is no suggestion in the records at hand that this attitude is not maintained by the lower beds as well. This general horizontality is locally modified, especially where beds of coal appear. In such places, as at Coal Valley, the whole series of beds above the coal lie in relatively narrow basins, or troughs, and have dips of approximately 30 feet to the mile. This low inclination, however, appears to represent the original inequality of the coal swamp and not to indicate any structural deformation.

ROCK ISLAND COAL

The Rock Island coal is recognized in small isolated basins of a few square miles in extent in T. 18 N., R. 1 E., in T. 17 N., R. 1 E., in T. 16 N., R. 1 W., and doubtfully in T. 16 N., R. 2 W. and in T. 16 N., R. 4 W. The coal ranges from three inches to six feet in thickness and is rarely uniform within a single mine. There is also considerable variation in character. In some places it shows no partings; in others two or more bands of pyrite or shale separate the bed into several benches. As a general rule the top coal is harder and commonly brighter than the lower. Where three benches are developed, the middle is usually the dullest and the bottom bench commonly contains the most pyrite in balls and lenses. The roof is dark shale, locally sheeted and slaty; commonly there is a cap-rock of dark argillaceous limestone. This is a fossiliferous stratum and carries the fusulina hitherto recognized as the index fossil of the limestone overlying the Belleville (No. 6) coal. This limestone is usually less than three feet in thickness, and is overlain by a relatively massive, slightly calcareous shale of dark bluish-gray color, commonly called the "blue rock" by the miner. The distinction between these two beds is more marked on weathered surfaces than in the freshly-cut sections. The "blue rock", however, contains relatively few fossils. The floor is in most places medium to light gray clay, soft, and without laminations.

Other Coal Beds

Other beds are recorded in many parts of the county. Locally, as in Drury Township (T. 16 N., R. 5 W.), they are nearly three feet thick and are worked as country banks. These have in no case been fully prospected, but appear to have an even less extensive development than the Rock Island coal and are considered of little commercial importance. Probably some of these beds lie stratigraphically above the horizon of the Rock Island coal, and some of them undoubtedly lie beneath that coal bed. The matter of stratigraphic relations can not be cleared up until some means of identification of the lower beds in the Pennsylvanian section are found.

SCHUYLER COUNTY

General Statement

Schuyler County lies just inside of the west margin of the Illinois coal field and as a consequence shows relatively thin Pennsylvanian beds between the drift and the Mississippian limestone formation below. Because of the shallowness of the "Coal Measures", erosion by streams, especially Crooked Creek on the west and Sugar Creek and Illinois River on the east, has removed these beds from relatively wide areas, as shown on the map (Pl. I B).

Production and Mines

The report of the Department of Mines and Minerals for 1923 records a total of 36 local mines in the county, producing a total of 25,636 tons. Of this tonnage 65 per cent came from the Rushville bed and the remainder came from the Colchester (No. 2) coal. The mines are so scattered over the county that practically every township is represented in the list. Many strip pits are operated in the summer months, but during the winter the other properties are actively worked.

Area underlain by workable coal	202 sq. mi.
Average thickness	28 inches
Amount available originally	538,100,000 tons
Production, year ending June 30, 1923	25,636 tons
Average annual production, 1919-1923	109,519 tons
Total production recorded	598,927 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

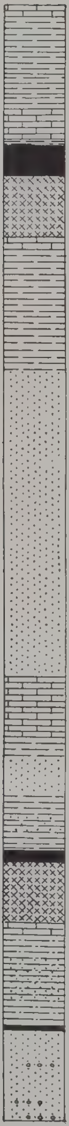
The Pleistocene deposits are of the usual type, but are relatively thin on the average. Various wells record from 7 to a maximum of 210 feet, but in the area underlain by "Coal Measures" the Pleistocene is probably little more than 50 feet thick.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds outcrop in most parts of the county, but are nowhere common. The more prominent outcrops are along the Little Missouri and other tributaries of Crooked Creek in the west, along Sugar Creek in the vicinity of Ray and Pleasant View, and along Coal Creek near Frederick. Very few logs showing the character and thickness of the Pennsylvanian beds have been reported from the county.

The accumulated data show the Pennsylvanian to range from a feather edge near the boundary of the beds to more than 200 feet in the Rushville area. The base of the series is not readily recognized because of the presence of similar beds in the upper part of the Mississippian formation. Therefore the total thickness may be increased by as much as 100 feet where this thickness of clastic beds is recorded on top of the main limestone of Mississippian age. Such additions to the known thickness appear in the logs from secs. 13, 15, 27, and 32 of T. 3 N., R. 2 W. (Littleton Twp.), and in sec. 3 of T. 2 N., R. 2 W. Above these basal beds which are doubtfully Pennsylvanian, lie the beds which are commonly exposed in the county. These are presented graphically as a generalized columnar section (fig. 13).

The lower four members in the section comprise the Pottsville portion above which lies the Carbondale with the Colchester (No. 2) coal with its underclay at its base. The lowest eight members, including the sandstone over the Colchester coal are found rather generally



Thickness *Feet*		
2	(I)	Limestone.
15		Shale.
5	(H)	Limestone, dense, gray, fossiliferous.
1		Shale, black, fissile.
5	(G)	Coal, (Rushville bed).
10		Under clay.
2	(F)	Limestone, nodular, fossiliferous.
20		Shale, fine.
50	(E)	Sandstone, massive, grading upward. Base uneven
10	(D)	Limestone, fossiliferous, flinty.
1		Shale, black, fissile, with pyritic concretions
5		Sandstone.
10		Shale, locally sandy.
2	(C)	Coal, (Worthen's No. 2).
10		Under clay.
2	(B)	Limestone, brecciated.
15		Sandstone and sandy shale.
1	(A)	Coal, locally developed.
15		Sandstone, locally conglomeratic.
184	Total.	

Fig. 13. Generalized columnar section for Schuyler County.

over the county. In the limited highland area north of Rushville and Pleasant View is an irregular patch where the Pennsylvanian beds are considerably thicker, and in which are found the upper eleven beds of the section.

PROMINENT BEDS

There are several prominent beds in the section by means of which it may be possible to make statewide correlation of the series in Schuyler County. These are listed below with the appropriate index letter referring to the generalized section (fig. 13):

I. The blue to buff, fine-grained limestone lying about 150 feet above the No. 2 coal.
H. A gray fossiliferous limestone lying 130 feet above No. 2 coal.
G. A 5-foot coal (Rushville) lying 125 feet above the No. 2 coal.
F. A gray nodular limestone 2 or 3 feet thick, 110 feet above the No. 2 coal.
E. A massive sandstone from 20 to 70 feet thick, lying 30 feet above No. 2 coal.
D. Dark blue limestone, cherty in upper part, argillaceous below, 10 feet thick, lying 20 feet above No. 2 coal.
C. Colchester (No. 2) coal.
B. Brecciated limestone 2 feet thick lying 10 feet below top of the Colchester coal.
A. No. 1 coal of Worthen, usually less than 1 foot thick, but locally developed in 2 benches with 18 inches of gray shale between. This bed lies 20 feet below the top of No. 2 coal.

Three coals are recognized in Schuyler County of which but two are worked, one in the limited area north of Pleasant View and the other in all parts of the county. These have been correlated as Rock Island or No. 1 bed at the base; Colchester or No. 2 bed about 25 feet over Rock Island coal; and Rushville or No. 5 bed about 125 feet over the Colchester coal.

As is usual in the strata of the Pennsylvanian system, there is considerable variation in the character and thickness in relatively short distances. Thus the following typical log of the upper portion of the section, taken from the shaft of the Root mine in sec. 23, T. 2 N., R. 1 W., shows some marked differences when compared with the generalized log in figure 13:

Record of the upper portion of the shaft of the Root mine, sec. 23, T. 2 N., R. 1 W.

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Drift	8	..	8	..
Limestone, gray	8	..	16	..
Shale, gray	4	..	20	..
Limestone, sandy	4	..	24	..
Shale, light gray	23	6	47	6
Limestone, "cap rock"	..	8	48	2
Shale, black, fissile	2	6	50	8
Coal, without partings	5	5	56	1
Clay, light gray	..	3	56	4
Coal, bony	1	6	57	10
Clay, light gray	4	..	61	10

While few logs are available which serve to indicate the character of the pre-Pennsylvanian surface, the general relations of the "Coal Measures" to the earlier strata clearly suggest that the former lies as a thin veneer over the uneven surface of the latter.

STRUCTURE

The Pennsylvanian beds, though essentially flat-lying, show a slight eastward dip, which may be original, although more probably is related to the upwarping of the Mississippian beds in the Colmar region. Selected data show a difference in altitude of the Colchester coal amounting to 62 feet in 20 miles. The limited workings in the coal do not reveal any minor structures of consequence.

The following statement from an earlier report of the Survey gives the structural relation of the beds in this county and in the adjoining area to the north[28]:

GENERAL STATEMENT

"Elevations upon either or both coal No. 2 and the basal contact of the St. Louis limestone were secured wherever possible at intervals of one mile or less. These elevations were recorded upon a study map which revealed the following general structure of the two beds.

"In general, coal No. 2 dips to the south of east—from the highest elevation of 630 feet, in secs. 25 and 26, T. 3 N., R. 5 W. (Augusta), Hancock County, to the lowest elevation of about 500 feet along Illinois River in the vicinity of Browning and Frederick, Schuyler County. Upon this larger structure in places there are some minor features which take the forms of small domes, anticlines, terraces, and synclines. The general dip, however, persists over large areas, and the coal bed lies nearly flat in a belt 4 to 6 miles wide stretching from Littleton to a point beyond Mabel and probably in a similar belt stretching southeast from Littleton through Rushville to Pleasant View, although elevations in this latter belt are very meagre because of the lack of coal outcrops.

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[28] Morse, W. C., and Kay, F. H., Area south of the Colmar oil field: Ill. State Geol. Survey Bull. 31 p. 29, 1915.

"Like coal No. 2, the St. Louis limestone in the region under discussion, has a general dip to the south of east. It dips from the highest elevation of 580 or 590 feet in the vicinity of Huntsville and the northwest part of Schuyler County to the lowest elevation of about 450 feet along Illinois River between Browning and Frederick. Furthermore, the total amount of dip of these two horizons is about the same, being 130 feet for coal No. 2 and 140 feet for the St. Louis limestone. Upon this general structure of the St. Louis limestone there are also minor structural features similar to those shown by coal No. 2.

"Because of the general parallelism between coal No. 2 and the St. Louis limestone, and especially because in areas where exposures of the one are absent, outcrops of the other are commonly present, it has been regarded advantageous to combine the data regarding the two beds in a single map on which the altitude of the beds has been shown by means of contour lines. Where coal No. 2 is present the contours represent elevations run to that bed; where it has been eroded, its former elevation was determined by running elevations to the base of the St. Louis limestone and adding to this figure the average thickness of beds between the base of the St. Louis and coal No. 2. This thickness is 40 feet at the southeast part of the area and increases regularly toward the northwest. At the northwest corner of Schuyler County the interval is 75 feet, as determined by Mr. Hinds in his work in the Colchester and Macomb quadrangles.

FOLDS SHOWN BY COAL NO. 2 AND ST. LOUIS LIMESTONE

"A minor dome has been found in the coal to the east of Littleton, its apex being in secs. 12 and 13, T. 3 N., R. 2 W. (Littleton). The bed in the immediate vicinity rises from about 550 feet on the southeast and from a little less than 580 feet on the north to its maximum elevation of about 600 feet. Both the St. Louis limestone and coal No. 2 between secs. 8 and 21, T. 2 N., R. 2 W. (Buena Vista), lie at elevations 10 to 20 feet higher than they do in the immediate vicinity to the north, east, and south, as indicated on the map (Plate I). It must be noted, however, that the rise of the beds is a *very* slight one.

"Coal No. 2 in secs. 14 and 9, T. 1 N., R. 2 W. (Woodstock), and the St. Louis limestone in sec. 33, T. 1 N., R. 2 W. (at Ripley), reach elevations 20 to 30 feet higher than they do in the adjoining territory. Between these points elevations of the beds are not available for the reason that they are not exposed at the surface. The area of elevated strata is probably about as that represented on the map (Pl. I) within the limits of the 540-foot contour line. It is also a *minor* feature with unknown limits.

"In sec. 7, T. 1 N., R. 2 W. (Woodstock), and in secs 10, 11, and 13, T. 1 N., R. 3 W. (Missouri)—that is, at Scott Mill—the St. Louis limestone reaches an elevation 50 or 60 feet higher than it does to the south. Although elevations are not obtainable to the north, the limits of the elevated beds are probably correctly shown by the 570-foot contour line. Coal No. 2 lies at a higher elevation along what seems to be a small anticline whose axis runs southwest from sec. 5, T. 1 N., R. 3 W. (Missouri), through sec. 13, T. 1 N., R. 4 W. (Pea Ridge); but here also the rise is only a few feet. The coal bed also rises rather rapidly westward from 520 feet to 580 feet in sec. 4, T. 1 S., R. 3 W. (Mt. Sterling); but unfortunately lack of exposures and of field study makes it impossible to state now whether this bed continues to rise in this direction or culminates here in its highest observed point.

"In the area under discussion the greatest elevation which coal No. 2 attains is near the county line slightly north of west of Huntsville where the bed is more than 630 feet above sea level. The exact nature of this structure is not clear, because the bed is concealed to the west. It seems probable that it is an elongated dome, although it may be a terrace from which the bed rises to the north or to the west, or in both directions. The structure is more pronouncedly revealed by the contours on the base of the St. Louis limestone which reaches its maximum height slightly to the northeast of that of coal No. 2, or along a curved line extending from secs. 34 and 35 northwest to sec. 17, T 3 N., R. 4 W. (Birmingham). From the east the St. Louis rises rather rapidly from 530 or 540 feet to 580 or 590 feet along this belt of elevated beds. Unfortunately there are no outcrops to the west which would show the altitude of the limestone farther in this direction, but the suggestions are that the bed dips to the west, beyond the belt of elevated strata, thus forming an elongated dome. If on the contrary the limestone rises to the west then the structure is a terrace rather than an elongated dome. At any rate, there is a sudden arrest of the rapidly rising limestone along this belt of elevated strata and there is a terrace on the steeper portion of the dipping limestone two miles east of Huntsville as shown on Plate I. The Huntsville uplift is represented graphically on the map by contours based on both the limestone and coal elevations."

Colchester Coal

As shown on Plate I B, there are two main areas in which the Colchester (No. 2) coal is mined, the smaller lying south of Huntsville mainly in T. 2 N., R. 4 W., and the larger centering about Rushville and occupying most of Tps. 1, 2, and 3 N., of Rs. 1 and 2 W. The deep incision by streams produces an extremely irregular pattern on the areal map. Over these two areas the Colchester coal ranges from 18 to 36 inches in thickness. The coal is relatively clean, having no persistent partings of foreign material. The top coal is usually somewhat harder than the lower part. The roof is uniformly shale from 5 to 20 feet thick, the upper part usually sandy. In places the sand content is so great that the whole bed is essentially a sandstone. The floor is gray underclay which in many places is sandy, though it serves well as an undercutting bed in most workings.

This coal is worked for local trade entirely, and most of the operations are on a very small scale, with limited mining equipment. Figure 14 showing a drift in sec. 36, T. 3 N., R. 1 W., represents the typical outside equipment for mines working the Colchester coal.

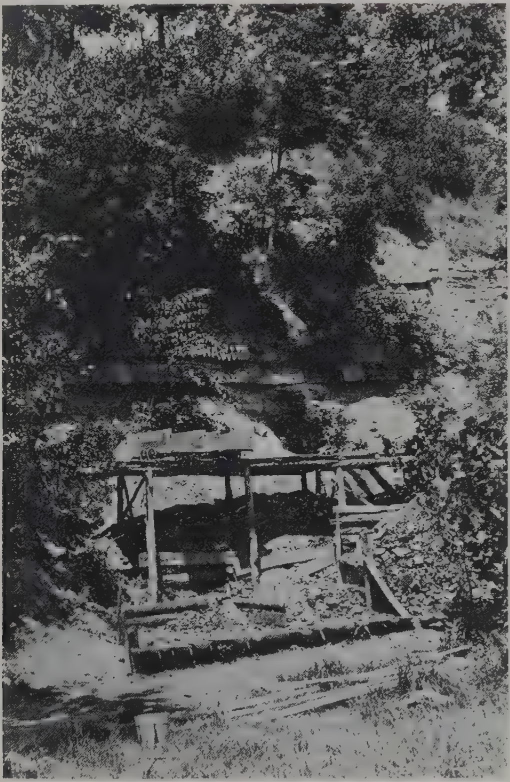

Fig. 14. Outside equipment of drift on Colchester coal, Gory's mine, Schuyler County.

Rushville Coal

The Rushville coal underlies only a small portion of the county, but has produced a large percentage of the coal mined. It underlies the area of highland north of Rushville and Pleasant View, but is not recognized outside of this field. It ranges from 60 to 72 inches in thickness and is quite uniform in any one mine. Like the Colchester coal it shows no partings or benches and is therefore relatively clean as mined. It is a soft coal of easy and irregular fracture, of dull luster with but few bands of glance coal in the bed. Pyrite and calcite appear throughout the coal in facings and pyrite lenses are not rare. Clay slips affect the bed in some mines, but these are of limited size and are not a great hindrance in mining.

The roof is regularly black "slate" from 2 to 3 feet thick which maintains an even contact with the coal. The cap lime 2 to 3 feet thick overlying this combines with the "slate" to make an excellent mining roof. In places these beds have been eroded and glacial drift makes the roof. This condition appears in some strip pits. The floor is light gray sandy clay which shows little variation and serves well as a mining bottom as it rarely gives trouble by heaving.

Other Coal Beds

In the vicinity of Frederick two coal beds appear which are not readily referred to the foregoing stratigraphic section. Only the uppermost of these is mined, as the lower is not known to be more than 15 inches thick. The upper coal now being worked in Spiller's mine in section 4, T. 1 N., R. 1 E., is about 34 inches thick, without benches or persistent partings. It shows pyrite and shale lenses with facings of calcite and pyrite throughout. The 18-foot shale comprising the roof is here overlain by 8 feet of limestone, overlain by 60 feet of sandstone. This resembles the succession over the Colchester coal east of Pleasant View.

There is also a lower coal outcropping in the vicinity of Pleasant View which is correlated as Worthen's No. 1. It is so split by shale partings as to be of no value where sufficiently thick for mining.

SCOTT COUNTY

General Statement

The "Coal Measures" of Scott County are quite similar to those of Morgan County to the north and of Greene County to the south, with the exception that the only beds appearing within the county boundary belong in the lower, rather than the upper part of the Pennsylvanian section (Pl. I B).

Production and Mines

Coal mining is of little consequence, except in the vicinity of Winchester, Exeter, and northeast of Alsey. At Alsey an extensive clay mine makes use of the overlying coal for a part of its supply. Nine mines producing a total of 5,120 tons were reported by the

Department of Mines and Minerals in 1923. This was approximately one-third less than in 1922.

Area underlain by workable coal	124 sq. mi.
Average thickness	24 inches
Amount available originally	280,000,000 tons
Production, year ending June 30, 1923	5,120 tons
Average annual production, 1919-1923	18,004 tons
Total production recorded	547,836 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The loess which caps the uplands of most of the county is thicker close to the Illinois, where it reaches a maximum of over 40 feet. The underlying Pleistocene deposits closely resemble those of adjacent counties. Boulder clay, sand and gravel make up the bulk of the deposits, ranging from 20 to 95 feet in thickness. In places, as northeast of Alsey, these beds lie immediately above the coal, which thus can be readily extracted by stripping. In the main, however, the Pleistocene deposits cause little difficulty in coal mining.

PENNSYLVANIAN SYSTEM

The "Coal Measures" underlie only the eastern half of the county, the Mississippian limestone outcropping in the creeks along the line of the bluffs, between Winchester and Alsey. Doubtless much greater irregularity exists in this line than appears on the map, which is based on a reconnaissance survey. As a result of this relation to the Mississippian beds, the "Coal Measures" thin to a feather edge at the west, while at the east margin they are nearly 175 feet thick. Outcrops are found along the creeks in the vicinity of Exeter, along Big Sandy about 2 miles east of Winchester and in sec. 14, T. 13 N., R. 12 W., northeast of Alsey. Farther west, the Mississippian rocks outcrop prominently along the creeks. Worthen[29] gives the following section as representative for the county:

Representative Pennsylvanian section for Scott County

Description of strata	Thickness *Ft.*	Depth *Ft.*
Sandstone and shale	30	30
Limestone	2	32
Bituminous shale (Coal No. 2?)	3	35
Sandstone and shale	35	70
Bituminous shale	5	75

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[29] Worthen, A. H., Geol. Surv. of Ill. Vol. III, p. 136, 1868.

Representative Pennsylvanian section for Scott County—Concluded

Description of strata	Thickness	Depth
	Ft.	*Ft*
Coal (Exeter No. 1)	3	78
Clay shale, dark blue	3	81
Limestone, dark blue, dense	4	85
Shale, or "potter's" clay	12	97
Sandstone, shaly and conglomeratic with iron ore and locally thin coal	12	109
Limestone, Mississippian		

The following section from the vicinity of Alsey is representative of the Pennsylvanian in the southern part of the county:

Typical Pennsylvanian section for southern part of Scott County

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Sandstone	15	..	15	..
Shale, sandy	1	6	16	6
Sandstone	..	10	17	4
Shale, medium gray	1	..	18	4
Shale, black fissile	3	..	21	4
Shale, light gray	..	3	21	7
Coal	2	2	23	9
Clay, sandy	..	8	24	5
Interval concealed (probably shale)	3	..	27	5
Limestone, brecciated, nodular	4	..	31	5
Clay, light to dark gray (Cheltenham)	6	..	37	5
Coal, lenticular, with 1 in. shale below	..	7	38	..
Limestone, (Mississippian)				

The similarity in the two sections above is marked, but the identification of the Exeter bed, made by Worthen, is probably incorrect. The presence of the bituminous shale or "slate" over the 36-inch coal, and of the dense nodular limestone 4 or 5 feet below the coal rather definitely fixes this as the Colchester or No. 2 coal of southwestern Illinois. This coal presumably underlies the eastern half of the county, whereas the thinner coal below is but locally developed and does not constitute an appreciable part of the coal of the county.

It does not appear that the base of the "Coal Measures" of this county is marked by great relief, but the lower portions may be the site of deposition of a basal coal corresponding to the No. 1 coal of Worthen's type section. The relation of the Exeter coal to that of the Neelys coal in the extreme western part of Morgan County is not clear. According to Worthen, the upper bed at Neelys lies 25 or 30 feet above the Exeter coal. It is there 48 inches thick, but does not appear to have any extensive development.

STRUCTURE

The beds lie essentially flat over the eastern part of the county, showing only a moderate dip which does not carry the coal below workable depths within the county limits.

EXETER COAL

Coal has been mined only in the vicinity of Exeter, Winchester, and Alsey, yet the Exeter bed appears to underlie the whole eastern half of the county. Available data do not show whether it is the same bed throughout the field, but the general character of the roof and floor and of the coal itself suggests this.

The bed has an average thickness of 30 inches and is not known to depart greatly from this amount in any mine. The roof is soapstone with black fissile shale above and gray shale over the "slate". The floor is gray clay about 2 feet thick underlain by a 3-foot bed of nodular, brecciated limestone, known as the "sump rock."

COAL BEDS BELOW THE EXETER BED

In several places in the county thin carbonaceous beds lie at or near the base of the Pennsylvanian strata. These locally may reach a thickness of about two feet, but because of their lenticular shape and generally bony character have not been attractive to prospectors, and therefore cannot be said to be a factor in the coal resources of the county.

WARREN COUNTY

GENERAL STATEMENT

Warren County lies at the western margin of the Illinois coal field and includes a small portion of the boundary of the Pennsylvanian beds (Pl. I A). This boundary is mapped approximately, but numerous well-logs located near the edge of the Pennsylvanian area indicate a very marked irregularity for this line. As drawn, it lies west of any of the known coal beds and approximates the margin of the main area of the "Coal Measures" disregarding the numerous small outliers of sandstone and shale. The western two-thirds of T. 12 N., R. 3 W., and the northern half of T. 11 N., R. 3 W., are underlain by Mississippian beds only. Elsewhere the Pennsylvanian rocks underlie the drift in considerable thickness.

PRODUCTION AND MINES

For many years past there have been no shipping mines in Warren County, although a considerable amount of coal has been obtained from year to year from the country banks. The annual production has varied greatly but at no time has it been important. In 1923 there were recorded nine local mines with a total production of but little more than 10,000 tons. These mines are scattered over the county from north to south with a majority in the southern two tiers of townships.

Area underlain by workable coal	281 sq. mi.
Average thickness	32 inches
Amount available originally	866,500,000 tons
Production, year ending June 30, 1923	10,312 tons
Average annual production, 1919-1923	29,087 tons
Total production recorded	513,381 tons

STRATIGRAPHY

PLEISTOCENE SYSTEM

The Pleistocene covering of the bed rock in Warren County is extremely uneven. This is in part due to the surface relief but is mainly accounted for by the irregularity of the bed rock surface itself. The greatest thickness recorded is 233 feet, in sec. 5, T. 11 N., R. 3 W. The drift includes considerable amounts of blue clay with some sand and gravel. In places buried soil and fragments of wood indicate the presence of more than one drift sheet.

PENNSYLVANIAN SYSTEM

The Pennsylvanian beds show thicknesses up to about 200 feet. These beds are largely sandy shale and shale with subordinate amounts of sandstone and little or no limestone. Because of the large amount of drift the outcrops of bed rock are few. In the northern part of the county they are found in the SE. ¼ of T. 12 N., R. 2 W. and in the NW. ¼ of T. 11 N., R. 2 W., about four miles north of Monmouth. In the southern part of the county, where the stream dissection has proceeded further, are numerous outcrops along creeks in T. 8 N., R. 2 W., and T. 8 N., R. 1 W., as well as in T. 9 N., R. 1 W. Further information on the Pennsylvanian beds is obtained from drill logs which are fairly well scattered over the county, although somewhat concentrated in the southern third.

A very large number of shallow borings have been made but these rarely reveal the bed rock below the drift. On the other hand a large number of deeper borings ended at the horizon of the Colchester coal so that relatively few logs show the thickness and character of the whole Pennsylvanian section in this county.

The general character of the Pennsylvanian beds is indicated by the following logs:

Log of boring in T. 8 N., R. 1 W.

Description of strata	Thickness *Ft.*	Depth *Ft.*
Clay, yellow	18	18
Clod, blue	2	20
Coal, Colchester	1	21
Slate, dark	29	50
Limestone, gray	8	58
Clod	2	60
Coal, Rock Island	3	63
Slate, black	12	75
Limestone, Burlington	125	200

Log of boring in T. 10 N., R. 1 W.

Description of strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Soil	1	..	1	..
Clay, yellow	17	..	18	..
Sand, yellow	10	..	28	..
Shale, blue	16	..	44	..
Limestone, white	2	..	46	..
Shale, black	18	..	64	..
Sandstone (water)	6	..	70	..
Rock, black	6	..	76	..
Sandstone	4	..	80	..
Limestone	10	..	90	..
Coal (Rock Island)	3	8	93	8

Two beds in the Pennsylvanian section have been used as horizon markers with fair success although identification of either in drill logs is open to question. One is the Colchester coal which appears to be recognizable in the southern part of the county, and the other is the fusulina limestone overlying a coal which is tentatively correlated with the Rock Island bed. The limestone is positively identified in sec. 15, T. 11 N., R. 2 W.; in secs. 14 and 24, T. 12 N., R. 2 W.; sec. 4, T. 9 N., R. 3 W.; sec. 9, T. 9 N., R. 2 W., and secs. 24, 25, 26, T. 9 N., R. 1 W. The Colchester coal has been tentatively identified in the southern part of the county where contours have been drawn on its upper surface.

The relation between the Rock Island and the Colchester coal beds is determined in but few places since both beds are rarely recognized in any one section. In places where the identification seems accurate, the upper bed is from 17 to nearly 40 feet above the lower. The intervening rocks are shale or sandy shale except for the clay below the upper coal and the thin limestone capping the lower.

In places a thin coal is reported lying below the Rock Island bed, but is nowhere of workable thickness and is therefore not considered in an estimate of the resources of the county.

In the northeastern part of the county a few logs record the presence of a coal of workable thickness which appears to lie too high to be correlated with the Colchester coal and is tentatively classed with the coals lying above that bed.

STRUCTURE

Little information is available for the determination of the structure of the Pennsylvanian beds in Warren County. No recognizable stratum is continuous over the area which is underlain by rocks of this system nor is it possible to use any combination of two beds to determine the structure. Earlier work in the area to the south,[30] however, resulted in the drawing of contours on the surface of the Colchester coal in the southern part of the county.

Examination of available data brings out the point that this bed shows no marked regional dip. Instead, it appears to be involved in a series of three upwarps, one of which plunges eastward, and the other two trend southwestward. The first arching in which a relief of nearly 80 feet is indicated is in the vicinity of Roseville and involves the beds from near Smithshire on the northwest to the southeastern corner of the county. A low broad arching is similarly shown near Cameron, but here the difference in elevation is but 40 feet. Apparently the area of sharpest folding lies between Gerlaw and Utah, in the northeastern part of the county, where, although the relief is less than near Roseville, the inclination is appreciably greater.

Inasmuch as these structures, as outlined, are based on limited data, and since where information is better the structures are more complicated, it is probable that these broad features of the structure are actually modified greatly by unobserved deformations and that a true structural map would exhibit numerous arches, basins, and other types of structure where present data indicate only smooth gentle slopes.

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[30] Savage, T. E., and Nebel, M. L., Geology and mineral resources of the LaHarpe and Good Hope quadrangles: Ill. State Geol. Survey Bull. 43, p. 9, 1921.

Colchester Coal

The most important coal in the county is that known as the Colchester coal. Over a considerable portion of the county this bed has been reported in mines and drill logs. In many of these places it has not been positively identified and about half the county is known to be underlain by it. Ranging from a few inches to about three feet in thickness, it still shows considerable uniformity and probably averages about 30 inches in the area mapped as containing workable coal. Because of its lenticular development it is probable that there are areas of thin coal within that mapped as one of commercial thickness. The thick cover of glacial drift may also conceal areas of workable coal lying outside the area mapped.

The coal is of fair quality in most places, and although mostly dull with but few bright bands, it shows no persistent partings of shale or bone. Facings of calcite and gypsum are common, as are small lenses and balls of pyrite. The roof is usually "soapstone", a light gray, rather massive shale which is sandy toward the top and in places grades laterally into sandstone. Above the shale is commonly a foot or more of fissile black shale, known as "slate" by the miners and which locally carries calcareous or pyritic nodules. The floor is uniformly gray plastic clay several feet thick.

Other Coal Beds

Because of its greater thickness and generally superior quality the Rock Island coal has been worked more than the Colchester bed. It is much less widely developed, however, and hence can not be considered as important a resource. It is known in two parts of the county, one northeast of Monmouth where it is about 42 inches thick and the other along the southeastern margin in which it is somewhat thinner.

The coal is relatively soft, and notably laminated with prominent bright and dull bands. A bony or shale parting near the middle is usually present, and the lower bench is softer than the top. Facings of calcite, gypsum and pyrite are common so that the ash and sulphur content are generally high. The roof is good, comprising a cap limestone with a foot or two of black fissile shale between it and the coal in places. The floor is sandy, either sandstone or sandy shale, which is in places overlain by a few inches of carbonaceous shale called "false bottom."

A third area of workable coal has been mapped in Warren County in the extreme northeastern part where little mining or testing has been done. The data from adjoining parts of Knox and Mercer counties, however, strongly suggest the presence of a bed of coal of workable thickness east of Alexis. This bed, which seems to lie above the horizon of the Colchester coal, is estimated to be about 30 inches thick, but so little is known of its extent or character that its value as a resource can easily be overestimated.

WHITESIDE COUNTY

General Statement

Whiteside County lies along the north margin of the Illinois coal basin, and includes only a few small patches of rock of Pennsylvanian age (Pl. I A). These are not known to contain any coal; hence there are no mines or prospect pits within the county boundaries.

Stratigraphy

PENNSYLVANIAN SYSTEM

The presence of Pennsylvanian rocks is known from outcrops, quarries, and borings. These show that the distribution of the beds is irregular, but the precise area underlain by them is not known. The section known comprises sandstone with thin interbedded shale. Fair exposures are found in the old quarries at Unionville and also about five miles southwest in secs. 19 and 20, T. 21 N., R. 4 E. Not more than 12 feet is exposed in any place, and while the rocks show some variation in bedding, it is nearly uniform in character. It is white sandstone of essentially clean quartz, iron stained on weathered surfaces, and not well cemented. It contains impressions of plant stems, and appears to have been deposited in fresh water or shore phase of the sea. From the relation in elevation between the Unionville quarry and the outcrop of Niagaran (?) limestone one mile east, and the absence of evidence of inclination of the sandstone bed, it appears probable that the Pennsylvanian rocks occupy depressions in the old limestone surface of pre-Pennsylvanian time. In this case they presumably are erosion remnants of a more widespread formation laid down near the margin of the area of Pennsylvanian deposition. The stratigraphic position of these sandstones is not clear. There is no available evidence suggesting whether they were deposited in early or late Pennsylvanian time. If a late overlap of Pennsylvanian phase occurred in Henry and Rock Island counties, it is logical to assume that these beds belong to that time.

SUMMARY OF COAL RESOURCES

For convenience of reference the tabulated matter presented in Table 4 has been repeated in part in the reports for each county. All available data have been utilized in the estimation of the coal resources, but it is obvious that such estimates must be approximate. The area underlain by workable coal was measured by planimeter from a base map on which the coal fields were plotted. Where two beds underlie the same field, the smaller area is not included in the total area for the county, although it is included in the estimate of total available tonnage. The average thickness of the coal beds in different parts of each county were combined with reference to the areas involved in each in arriving at an average thickness for each county.

Production figures have been taken from the reports of the Department of Mines and Minerals, which contain the most nearly accurate record of statewide production. Recognized inaccuracies appear here also, particularly in the decades preceding 1900, but these are mainly of omission and correction of them would serve to slightly increase the estimated production.

On the commonly accepted assumption that nearly as much coal has been rendered unfit for mining as has been mined, an idea of the present available tonnage is obtained by subtracting from the estimated originally available tonnage about 1.8 times the recorded total production.

Because of the overlapping of the adjoining districts the inclusion of certain counties in the figures for District III has necessarily been arbitrary. Thus in the case of Bureau County, so small a part of the whole county is included in the district that figures for area and production are not significant, and are omitted. Similarly for Fulton, Jersey, Knox, Madison and Mason counties the figures for production are not presented because of the impossibility of separating the small tonnage properly to be credited to the coals of District III from that for the whole county. Estimates of area of workable coal, average thickness, and original tonnage for these counties are, however, included, except that no attempt has been made to include the area underlain by the lower coals where the upper coals are of importance.

TABLE 4.—*Summary of coal resources in District III*

County	Area of workable coal	Average thickness	Original tonnage	Production	
				1881-1923	1923
	Sq. mi.	*Inches*		*Tons*	*Tons*
Adams	369	24[b]	838,720,000	464	....
Brown	182	24	412,820,000	26,489	150
Calhoun	8	24	17,900,000	96,087	....
Cass	265	36	897,000,000	182,609	9,014
Fulton[a]	.....	...	....	....	....
Greene	204	24	461,000,000	407,006	8,811
Hancock	7	30	19,270,000	243,473	9,313
Henderson[a]	22	29[b]	59,580,000	....	....
Henry	307	43[b]	1,247,530,000	4,754,791	58,074
Jersey[a]	11	24	24,600,000	....	....
Knox[a]	517	36[b]	1,727,000,000	....	....
Madison[a]	29	24	65,750,000	....	....
McDonough	267	24	604,700,000	2,204,138	39,275
Mercer	127	34[b]	412,130,000	13,689,352	400
Morgan	533	27[b]	1,340,500,000	83,219	25,964
Pike[a]	85	24	193,000,000	....	....
Rock Island	63	29[b]	171,760,000	3,098,876	63,035
Schuyler	202	28[b]	538,100,000	598,927	25,636
Scott	124	24	280,000,000	547,836	5,120
Warren	281	32[b]	866,500,000	513,381	10,312
Whiteside	.....	...	....	....	....
Total	3,603	...	10,177,860,000	26,446,648	255,104

[a] Statistics not available.

[b] Figure obtained by calculation involving areas of different beds.

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PUBLICATIONS
ILLINOIS MINING INVESTIGATIONS

ILLINOIS STATE GEOLOGICAL SURVEY DIVISION
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DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

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BULLETIN 30

COAL LOSSES IN ILLINOIS

BY

C. A. ALLEN

ILLINOIS MINING INVESTIGATIONS

Prepared by the U. S. Bureau of Mines, with the collaboration of the Illinois Geological Survey and the Engineering Experiment Station of the University of Illinois

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STATE GEOLOGICAL SURVEY

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PREFACE

In the course of the inquiry conducted by the Bureau of Mines, Department of the Interior, for the United States Coal Commission, into losses incurred in mining bituminous coal in the eastern part of the United States, a study was made of the principal coal-mining districts of Illinois by the late C. A. Allen.

Coal losses in the Illinois field have received unfavorable comment from mining engineers for at least a decade, and the present period of depression is serving to awaken the interest of the more progressive operators in the problem. It is believed that the presentation of the detailed data obtained by Mr. Allen, not involving mine labor and surface subsidence problems, will be of value to those concerned with the coal industry.

The chief merit of the report lies in the fact that it is the result of a comprehensive and systematic, though rapid, survey of the more important coal mining districts of the State by an especially competent and impartial observer.

The coal-mine operators of Illinois cordially cooperated in supplying data requested, assisted in preparing records and estimates, and courteously facilitated examination of mines and records. Advice and assistance were also cordially given Mr. Allen in his studies by the various officials of the State mining, geological, and educational branches.

The work was conducted through C. E. Lesher of the Engineering division of the Commission, and his assistant, W. M. Drake, Jr., and was under the supervision of H. Foster Bain, Director of the U. S. Bureau of Mines, and George S. Rice, chief mining engineer of the Bureau of Mines, and during his absence in Europe, of J. W. Paul, chief of coal-mining investigations of the Bureau.

M. M. LEIGHTON, *Chief*,
Illinois Geological Survey.

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COAL LOSSES IN ILLINOIS

By C. A. Allen

GENERAL SUMMARY

Eleven fields in twenty-seven counties are discussed in this report, and represent nearly the whole of the coal output of Illinois, which amounts to between 60 and 88 million tons annually. In 1921 the output was almost 70 million tons. Twenty mines were examined and data were procured from 131 mines, accounting for half of the coal mined. Omitting the Northern Illinois field, in which the longwall system of mining is employed, and where the extraction is 95 per cent, the losses in the other fields are much the same, and vary between 43 and 53 per cent, and average 49.7 per cent. This means that, in the mining of 69,785,000 tons, as in 1921, an amount almost equal to this total, namely 67,045,000 tons, was lost. Pillars account for most of this loss, the average being 39 per cent; but the investigation showed that 32 per cent of this loss is avoidable. Therefore, instead of the extraction being 50 per cent, it should be 82 per cent. In southern Illinois there is a rather large loss of roof coal—namely, 7 per cent; while in Peoria and Fulton counties there is a heavy loss of 15 per cent due to coal being left under water-bearing strata and wet and tender roof.

COAL LOSSES IN THE NORTHERN ILLINOIS COAL FIELD

Introduction

This report covers that part of northern Illinois where mining is carried on by the longwall method, and includes the following:

Table 1.—*Coal production of mines in northern Illinois*

County	Mines	Tons in 1921
La Salle	7	384,813
Bureau	5	556,671
Marshall	2	229,907
Grundy	2	202,926
Total	16	1,374,317

One trip was made underground in this field, and five operators were interviewed.

In addition to the longwall mines which are working No. 2 bed, or the so-called "Third Vein", there is one room-and-pillar mine in No. 5 bed. This mine produces about 170,000 tons per year, and recovers approximately 50 per cent of the coal. To include this with the longwall mines would tend only to confuse, and as it has not sufficient tonnage to be reported alone, it would seem better to neglect this mine altogether.

In the longwall mines, the only effort made was to determine if any appreciable amount of coal was left under buildings, railroads, or streams; and after studying this factor, and discussing the matter with three companies, it was found that the coal left thereunder amounts to only a fraction of one per cent.

The only other loss possible is in the coal thrown back with the impurities. The seam is about 3½ feet thick, and there are occasionally sulphur bands through it, but they occur with no regularity. Also, occasionally the roof coal sticks to the overlying rock. George S. Rice, chief mining engineer for the Bureau of Mines, Department of the Interior, states that careful figures kept over a period of five years showed that 95 per cent of the coal was recovered at one mine; and the late H. H. Stock of the University of Illinois stated that at another mine the loss from coal thrown back with impurities amounted to 7 per cent. Inasmuch as figures from some other longwall districts have shown a loss of only 4 per cent, it is assumed that the loss in this field is approximately 5 per cent.

TABLE 2.—*Summary of coal losses in northern Illinois*

Reason for loss	Percentage of marketable coal lost in area worked	
	Avoidable loss	Total loss
Coal left as roof and bottom coal	Fraction of 1	..
Coal lost in room, entry, and panel pillars	None	..
Coal lost in oil or gas-well pillars	None	..
Coal lost under buildings, railroads and boundaries	Fraction of 1	..
Coal lost in handling and preparation, underground and surface	5	..
Coal lost due to rolls, thin or dirty areas, or streams	None	..
Total loss, per cent	5	0

Losses in Overlying Coal

Inasmuch as the lower seam being worked is only 3½ feet thick, and is 80 feet below No. 5 bed, the writer would not expect the No. 5 bed to be seriously affected. At one mine, where No. 5 is being worked, it is reported that the roof is cracked a little, but otherwise it gives them no trouble, and the recovery of the coal is not influenced by the work underneath.

COAL LOSSES IN THE PEORIA AND FULTON COUNTY FIELDS

Introduction

This district comprises the counties of Peoria, which has 11 shipping mines with a production of 1,102,002 tons in 1921; Fulton, with 28 mines, producing 1,471,137 tons; and Tazewell, with 7 mines, producing 691,359 tons. The total production of the district in 1921 was 3,264,498 tons. This district comprises part of District IV of the Illinois Coal Mining Investigations,[1] and in University of Illinois Bulletin 100[2], the following description is given:

> "In District IV the No. 5 coal is mined. The average thickness of this coal is 4 feet 8 inches, according to data taken at 240 mines and given in the Thirty-first Annual Coal Report of Illinois. The No. 5 bed outcrops in Peoria, Fulton, and Knox counties, but is found at greater depths toward the east.
>
> "The roof is of black sheety shale varying in thickness from a few inches to 35 feet, and containing occasionally "nigger-heads" of pyrite. In many mines there is, in places, a layer of pyrite 2 or 3 inches thick between the coal and the shale. Where this layer is present, the shale is protected from the air and stays up; where it is not present, the shale falls badly, and sometimes caves to a height of 35 feet. A limestone occurs above the shale in most mines, though in a few places a fine grained micaceous sandstone is found. In some cases the shale is absent, and the cap-rock becomes the roof.
>
> "A great many clay veins extend through the coal and the roof shale; there are also small faults, slips, and rolls, and places where the coal has been eroded and the space has been filled with drift. It is difficult, therefore, to calculate the total tonnage and to project any plan of operation. In many places the coal adheres to the roof and separates from it with difficulty. In one mine about an inch of coal is left to protect the roof shale from the air. In most mines the floor consists of a dark gray clay which heaves badly when wet."

The coal bed in the area covered by this report is from 4 to 5 feet thick, averaging about 4 feet 4 inches. The principal impurity consists of clay veins, which are very irregular both in size and distribution. Two mines were examined in the district, and data were secured from mining engineers of 3 other mines. The method of mining is room-and-pillar, and the workings are usually laid out in panels. Rooms are driven 30 to 35 feet on center, and are from 22 to 30 feet wide. Barrier pillars, 30 to 35 feet wide, are left along the main and cross entries.

---

[1] Cady, G. H., Coal resources of District IV (Peoria-Springfield): Ill. Coal Mining Investigations Bull. 26, 1921.

[2] Young, C. M., Percentage of extraction of bituminous coal with special reference to Illinois conditions: Engineering Experiment Station Bull. 100, p. 36, 1917.

Losses of Coal

Coal is not left to support valuable surface as in the Springfield district of Illinois. Some of it is good farming land, but most of the country is rough and hilly. The only place pillars are left is along railroads and streams. In some parts of the field there are water-bearing formations lying above the coal, so that when the roof is cracked a large quantity of water comes into the mine. Just how this water occurs is not known, but it apparently does not affect much of the area being mined. No attempt is made to recover any pillars either under water-bearing strata or elsewhere. In addition to the coal left in the pillars in the regular work, considerable areas are left where the roof is very tender and wet. Theoretically, the area of the bed lost is from 24 to 35 per cent, but the superintendent of one of the mines visited reported that he had made a careful estimate, and found that they were getting only between 45 and 50 per cent, which would mean a loss of between 55 and 50 per cent. The chief engineer of another company stated that in 1921 he planimetered a map of the workings, and checked it against the tonnage hoisted, and found they had saved only about 40 per cent of the area worked over. From figures on the same mine for a number of years past the coal saved amounted to slightly less than 37 per cent. Of the 60 per cent lost in 1921, about 10 per cent was lost in areas abandoned owing to a wet and tender roof. If these figures had not been secured, the writer would have placed the extraction at well over 50 per cent, but at the mine where they had carefully estimated between 45 and 50 per cent recovery this was believed to be a very good average of the district, so the figure 47 per cent has been accepted.

In this field some solid coal is left under streams, and at the mines examined the coal so left amounted to approximately 3 per cent. Inasmuch as the railroad ran along the stream, the same coal serves to support it. The depth of the cover is not great, ranging from a few feet up to about 150 feet, so that any caving of the roof would be readily transmitted to the surface. The coal lost in handling and preparation is probably not as high as in the Springfield district, because the clay veins are less frequent in most mines, and consequently less coal is wasted in throwing out the clay.

On the basis of present information the writer would therefore put the loss as follows:

Cause of loss	Per cent
In room, entry, and panel pillars	35
Under streams and tender roof	15
In handling and preparation	3
Total loss	53

AVOIDABLE LOSSES

The coal lost under streams and railroads and that lost in handling and preparation are unavoidable. Of the coal left as pillars, unquestionably some is necessary on account of the water conditions overhead. However, the pillars which are now being left are not sufficient to hold the roof up for any great length of time. Some of the operators claim that a sandstone not far above the coal will prevent any surface cracks, which may be the case over part of the field, and of course where this is so, the condition would be changed by a systematic pillar drawing, because the sandstone would have to break. From the writer's observations, taking into consideration the fact that certain parts of the field have no trouble with water, and a high percentage of the coal could be extracted, it is believed that it would be reasonable to assume that 75 per cent could be saved in the entire field, which would be 28 per cent more than they are saving at the present time—that is, the avoidable loss is 28 per cent.

TABLE 3.—*Summary of coal losses in Peoria-Fulton county fields*

Reason for loss	Percentage of total marketable coal lost in area worked	
	Total loss	Avoidable loss
Coal left as roof and bottom coal	None	..
Coal lost in room, entry, and panel pillars	35	.28
Coal lost in oil or gas-well pillars	None	..
Coal lost under buildings, railroads and boundaries	Included in above and last item	
Coal lost in handling and preparation, underground and surface	3	..
Coal lost due to rolls, thin or dirty areas, and streams[a]	15	..
Total loss, per cent	53	28

[a] Includes coal left under wet and tender roof.

COAL LOSSES IN THE CENTRAL AND BELLEVILLE DISTRICTS

Introduction

The Central and Belleville districts have been combined in this report as all the general conditions are similar in both; but separate summaries have been made for each district as there is a difference in the percentage of coal extracted. The Belleville field includes what is frequently known as the Centralia field. Some details of production are given in the following table:

Table 4.—*Coal production of the Belleville and Central fields*

Belleville district			Central district		
County	Mines	Tons, 1921	County	Mines	Tons, 1921
St. Clair......	55	6,281,000	Macoupin........	17	7,516,000
Randolph.....	10	1,894,000	Montgomery.....	9	322,000
Clinton.......	5	1,165,000	Christian........	11	3,216,000
Marion........	3	842,000	Sangamon (southern part)..........	4	1,845,000
Perry (part)...	9	822,000			
Madison......	20	4,216,000			

Four trips were made underground in the two fields, and definite data were secured on 47 mines producing a total of 14,000,000 tons annually.

Description of Coal Seam

The coal being mined in these fields comes from the No. 6 bed of the Illinois Geological Survey, and in general, the conditions are similar to the No. 6 bed where it had previously been studied in other districts. The thickness of the seam varies from 4½ to 9 feet, and probably averages 7¼ feet. It is a little thicker in the western part of the Belleville field than it is in the eastern part, and apparently attains its greatest average thickness in Macoupin and Christian counties. The only persistent impurity in the bed is the "blue band", which occurs about 18 inches from the floor. The other impurities contained are mother coal and sulphur bands. The latter occur to a greater extent in the northern part of the Central field than in the Belleville field.

The thickness of cover ranges from 16 to 232 feet in St. Clair County, from 45 to 330 feet in Randolph County, from 318 to 410 feet in Clinton County, from 600 to 714 feet in Marion County, and from

86 to 287 feet in Madison County—all in the Belleville field. In the Central Illinois field, the coal in Macoupin County has a cover of 268 to 380 feet; in Montgomery County, 380 to 640 feet; in Christian County, 360 to 735 feet; and in Sangamon County, from 270 to 328 feet. These are the depths of the working shafts, and due to the generally flat surface of the country, give the approximate thickness of cover.

Character of Roof and Floor

The roof and floor of No. 6 bed in these districts are, generally speaking, the same as in southern Illinois—that is, there is the usual cap-rock of limestone, lying from a few inches to 30 feet above the coal, and between this limestone and the top of the coal there are bands of material grading from a soft clay to a hard "slate". Wherever the limestone lies within a few inches of the coal it makes a good roof, but wherever it is high above the coal, and the material between is soft, there is a very bad roof (fig. 1). Sometimes in one mine, an entry will have these extremes of roof within 2,000 feet. Gener-

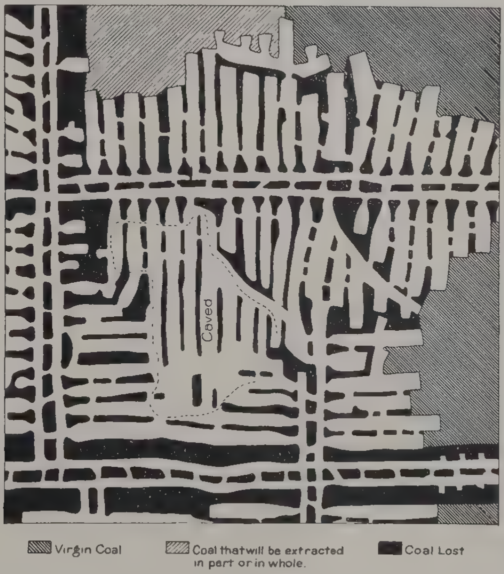

Fig. 1. Section of mine workings in Greene County showing coal lost by caved roof due to thin pillars.

ally the roof is better in the Belleville field, which means that over more of that area the cap-rock comes close to the coal. Because Madison County has a good roof over much of the area it has been included in the Belleville field. Some roof coal is left up in the Central field, on account of the greater area of tender roof and the tendency of the bed to attain a thicker average.

The floor is fire clay, varying in thickness, with a harder stratum of rock below it.

Method of Mining

Room-and-pillar methods of mining are used exclusively, with the exception of one longwall mine in Christian County, which is in the No. 2 bed, and has not been considered. In the southern part of the Belleville field there are more mines using straight room-and-pillar system than there are mines using the panel system; but the opposite is the case in the Central district. The widths of rooms and pillars vary considerably, and there is apparently no relation between the thickness of cover and the dimensions of the workings, except where the cover is very shallow. In the Belleville field one mine with a 150-foot cover and a good roof has 30-foot rooms on 60-foot centers; the room-necks, crosscuts, and room entries are all 21 feet wide. At another mine close by where the roof is bad the entries are narrowed, but the dimensions of the rooms are not changed, and reliance is placed upon the timber to hold up the bad roof. Another mine in the Belleville district has 30-foot rooms on 54-foot centers, with wide entries and crosscuts. The cover is 307 feet. Another mine with a cover of 380 feet has 40-foot rooms on 80-foot centers. Where the roof is bad the entries but not the rooms are narrowed. Another mine with 220 feet of cover has 35-foot rooms on 70-foot centers; the entries are from 14 to 21 feet wide, and room-necks and crosscuts are 21 feet wide. Nearly all the rooms are approximately 250 feet in length. At one mine in the southern part of the Central Illinois field, rooms 280 feet long are driven 40 feet wide on 80-foot centers. At several other mines near the southern part, rooms are 30 feet wide on 60-foot centers; the room-necks and entry crosscuts are all 21 feet wide; also entries are 21 feet wide. The room crosscuts are 30 feet wide. The cover is 309 to 342 feet. At one mine in the northern part of this district, rooms are 26 feet wide on 45-foot centers. The depth of cover is about 250 feet. At another mine rooms are 24 feet wide on 40-foot centers, with room-necks 12 feet wide. The entries are also narrow, the cover being 352 feet. At one mine in the northeastern part of the Central field, rooms are

30 feet wide on 55-foot centers; the cover is 450 feet, but room-necks and entries are narrowed to 10 or 12 feet. In nearly all mines where the panel system is used the barrier pillars are about 70 feet wide, and the fire pillars between the ends of the rooms are 10 to 20 feet wide.

Calculation of Coal Losses

Despite the fact that the same formation occurs over the entire area, there is a great variation in the immediate roof conditions, and considerable time was spent trying to determine how much of the area was affected by the roof conditions. The State mine inspectors furnished considerable information, also some mine superintendents and surveyors were met who were familiar with many different mines. A number of calculations were made, taking the actual dimensions of the working places as a basis, and showing a loss in the pillars of from 37 to 45 per cent in the Belleville field, and from 40 to 48 per cent in the Central Illinois field. In the panel work, the barrier pillars amount to from 5 to 10 per cent of the total loss; and in the straight room-and-pillar work they amount to less than 2 per cent. In top coal the loss is negligible in the Belleville field, but in the Central field a number of mines leave roof coal in a certain number of the rooms. After much inquiry, it is believed that the figure of 1½ per cent represents the average over the entire Central field.

ACTUAL FIGURES ON EXTRACTION

BELLEVILLE FIELD

Four coal-mining engineers in this district report that their extraction is 54 per cent, 60 to 65 per cent, 52 to 55 per cent, and 50 per cent, respectively. The writer examined a large number of maps in the Court House at Belleville, and found that the last mentioned company leaves a great deal of pillar coal, and its extraction could not average 50 per cent if the surveying were accurately done. However, they were mostly small mines.

Taking into account the relatively high percentage of unusually good roof in the Belleville field, the writer's estimation is that extraction is almost 55 per cent.

CENTRAL ILLINOIS FIELD

Some of the figures of recovery from No. 6 coal in the Central field covering the southern part of Sangamon County were given in the report on the coal losses in the Springfield District. The following figures were given by engineers for different companies: (1) 50 per cent; (2) 7 mines in Sangamon County including mines in No. 5 and

6 beds average 48.12 per cent; six mines in Christian County operated by the same company average 49.94 per cent; (3) in northern Macoupin County, 51½ and 52 per cent, and in Montgomery County, 43 per cent; (4) at Divernon in northern Macoupin County, 47 per cent, and at Mt. Olive in southern Macoupin County, 48.6 per cent; (5) mines near Gillespie, 50 per cent, except in one mine where top coal is left owing to bad roof, and where the extraction is 54 per cent. Taking everything into consideration, the writer estimates that the extraction is 50 per cent, based on the assumption that no attempt is being made to recover barrier pillars on the retreat.

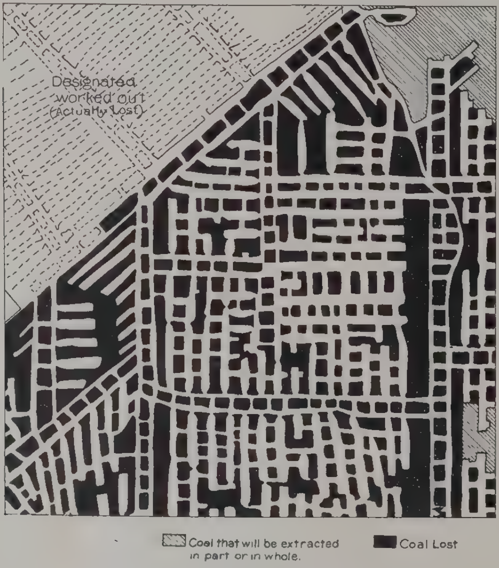
Designated worked out (Actually Lost)
Coal that will be extracted in part or in whole.
Coal Lost

FIG. 2. Section of mine workings in St. Clair County showing pillars not extracted.

AVOIDABLE LOSSES

The principal reason for leaving the pillars in this area is the high value of the surface land (fig. 2); this excuse, however, is not applicable over the entire area. Around Belleville, and in the entire Belleville field, there is considerable rolling country where pulling pillars would do practically no damage. In Madison County, the country is rolling from Collinsville to Edwardsville; from Edwardsville to Staunton it is very level, but from Staunton to Gillespie it is rough again. Around Hillsboro it is rough, and pillars could well be extracted. It is of course impossible to state all the conflicts that would come up in an attempt to draw pillars, but it seems to the writer that 80 per cent extraction should be secured in the Belleville district as a

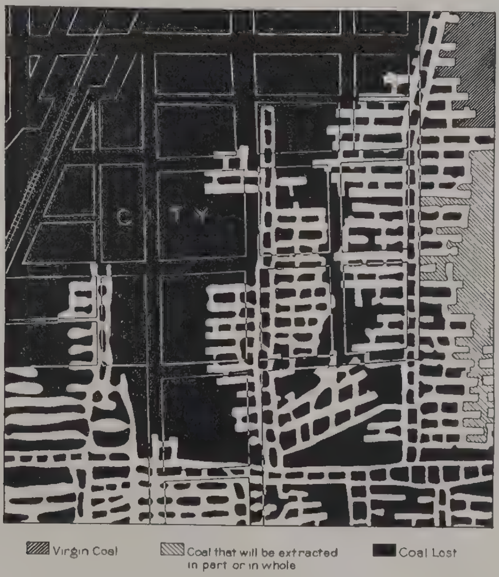

FIG. 3. Coal lost by protection of surface improvements. Section of mine workings in Randolph County.

TABLE 5.—*Summary of coal losses in the Belleville and Central fields*

Reason for loss	Percentage of marketable coal lost in area worked	
	Total loss	Avoidable loss
Coal left on roof and bottom	0.7	..
Coal lost in room, entry, and panel pillars (fig. 3)	43.0	26
Coal lost in oil or gas-well pillars	None	..
Coal lost under buildings, railroads, and boundaries	0.8	..
Coal lost in handling and preparation, underground and surface	2.7	..
Coal lost due to rolls, thin or dirty areas, and streams	0.3	..
Total loss, per cent	47.5	26

whole. In the Central field there is more level land, and as discussed in the report on the Springfield district, some coal should be left, so its possible extraction is 77 per cent.

There is one thing that must be taken into consideration. In the Belleville field limestone forms the roof in probably one third of the area. This makes an excellent roof, and except where the limestone thins out it should stand almost indefinitely, which means that the workings could be re-entered at any time and the pillars extracted. If this should ever be done, it would increase the extraction in the Belleville field, taken as a whole, by approximately 10 per cent.

COAL LOSSES IN THE SPRINGFIELD DISTRICT

Introduction

The district covered in this report includes the counties of Logan, Macon, Menard, and Sangamon. Logan County has 3 shipping mines, and produces approximately 345,000 tons; Macon County has 3 shipping mines, and produces 227,000 tons; Menard County—the number of mines unknown—produces 341,000 tons; Sangamon County has about 29 mines, and produces 5,957,000 tons, of which 1,800,000 tons come from No. 6 bed. Practically all the other mines in the counties named are in No. 5 bed.

In studying this district, two trips were made underground in No. 5 bed, and one in No. 6 bed, and eight different maps were studied.

Coal Reserves

The State Geological Survey of Illinois has recently made a careful survey to determine the coal resources of the different fields in the State, and its resource figures are therefore based on practical rather than on theoretical considerations.

Beds Being Worked

Both No. 5 and 6 beds, as defined by the Illinois Geological Survey, are being worked in this district. The mining conditions are very similar, with the exception of the conditions brought about by the difference in the impurities which are found in the beds. No. 6 bed is mined in Sangamon County, south of Springfield, and is 6 to 7 feet thick. It has a very persistent band of dirt near the bottom called the "blue band", about ½ inch thick. There are also usually two or three dirt bands through the bed, but they do not occur with the same regularity as the "blue band". This bed lies from 270 to 320 feet below the surface. The No. 5 coal is from 4½ to 7 feet thick, and averages approximately 6 feet. Its impurities consist of clay veins or "horsebacks" as they are locally known, and an occasional band of sulphur. The clay veins are the most difficult to overcome in mining because they are sometimes found every 15 or 20 feet throughout the bed, and have a thickness varying from a knife-blade up to several feet. Again, in other places, workings will be carried for 100 or 200 feet without encountering a single clay vein. The No. 5 coal lies from 160 to 600 feet below the surface, but throughout most of the field it is from 200 to 250 feet.

Nature of Roof and Floor

The immediate roof over No. 5 bed is either a black "slate" or a gray shale, either of which varies greatly in thickness. They are usually from 6 to 18 inches thick, and are overlain in places by a few thin strata of soapstone and sandy shale. Above these softer strata there is nearly everywhere a cap-rock of limestone or sandstone varying from a few inches to several feet thick. The condition of the roof depends upon the toughness of the immediate roof. As a rule, the black "slate" holds well unless broken by too many clay veins but the gray shale is usually tender. It might be said that 25 per cent of the roof is very good, 25 per cent is very bad, and the remainder medium.

The roof over No. 6 bed is generally the same as over No. 5, and further study will be made regarding it in the field farther south. No roof coal is left up in No. 5 bed, but occasionally some is left in No. 6 bed, especially in the entries.

Method of Mining

All the mines are opened by shafts, and the room-and-pillar method of mining is employed exclusively. Practically all the operators are adopting the panel method with 40 to 50 rooms in each panel. Barrier pillars of 50 to 75 feet are left along the cross entries, which are usually 12 feet wide on 42-foot centers. Room entries are 12 feet wide on 32-foot centers, and the rooms are driven 24 to 26 feet wide on 40 to 45-foot centers. Sometimes the rooms are holed through into the adjoining panel, but the tendency is to leave about a 10-foot fire pillar. No attempt is made to recover any room pillars, and probably a very small percentage of the barrier pillars will be recovered on the final retreat.

Surface Value of Land

The reason given by the operators for not pulling any pillars is that they do not own the surface rights, and that the owner will demand a large compensation if any subsidence takes place. It not infrequently happens that a squeeze comes on which causes a surface depression and forms a pond. The land is valued at from $200 to $400 an acre for agricultural purposes. In addition, it has a sentimental value in many cases, from the fact that it has been owned by the same family for several generations. So far as time permitted, the writer carefully observed the topography of the surface, and it can be stated that a perfectly level piece of land a mile square is rare. Usually at intervals of less than a mile there are areas in which the surface has been cut by shallow washes. Practically all the level portions are tiled at costs ranging from $10 to $35 per acre.

Owing to the fact that sufficient coal is left to hold up the surface, no attempt is made to leave solid pillars under railroads, buildings, or streams. Occasionally a farmer will have the coal reserved under his own buildings, and one or two cases were found where pillars had been left under power-plants. Also, where a railroad had purchased its right-of-way prior to acquisition of the coal by the coal company, that part of the bed which lies immediately under their right-of-way may not be mined.

These conditions are mentioned because they must be taken into account in deciding whether the coal loss is avoidable or unavoidable. Undoubtedly, under most tracts the coal could be taken out clean, and the surface let down practically as smooth as it was before, and the land would not be damaged to any appreciable extent for agricultural purposes. The pillar pulling, however, would have to be started with due consideration for the surface topography so that the subsidence would not create a large pond; also, the coal would have to be taken very clean. If this were done, pillars would have to be left under the railroads and under the towns—at least, under all large buildings. Whether pillars would be necessary under the concrete roads is a debatable question.

Calculation of Losses

The coal left as roof coal in a few of the mines and distributed over the entire field amounts to only a fraction of 1 per cent, and can be neglected. The coal lost in the room, entry, and panel pillars depends a great deal upon the occurrence of the clay veins. At one mine in No. 5 bed where 24-foot rooms were used on 40-foot centers, it was found that where it was free from clay veins, rooms would be wider than 24 feet, but where the clay veins were frequent, the rooms would be sometimes narrowed down to 12 feet. One operating company has six mines all developed with the same dimensions of working places, and their theoretical loss in pillars is 44 per cent, making a recovery of 56 per cent, not including the loss in handling. The result of calculations at another mine where somewhat larger barrier pillars are left indicates a loss of 48 per cent in pillars.

The coal loss resulting from handling and preparation is fairly high, due to the dirt seams in No. 6 bed and the clay veins in No. 5 bed. The writer believes that if the entire seam were mined, at least 8 per cent of the coal would be lost owing to impurities; but as only half of the seam is being mined, it would mean only a 4 per cent loss on the total tonnage. The summary of the losses is given in Table 6.

AVOIDABLE LOSSES

Not over 50 per cent of the coal can be safely mined under the towns, and it would probably be advisable not to mine over 40 per cent. The towns probably do not occupy 5 per cent of the total area being mined, and if 60 per cent of the coal is lost under them, it would mean a loss of 3 per cent. Solid pillars of coal should be left under railroads and under hard-surfaced roads. If it is assumed that two railroads and a cement road cross each coal holding at an angle, and also that the coal holdings are four miles wide, solid coal 800 feet or more

TABLE 6.—*Summary of coal losses in the Springfield district*

Reason for loss	Percentage of total marketable coal lost in area worked	
	Total loss	Avoidable loss
Coal left as roof and bottom coal	Fraction of 1	..
Coal lost in room, entry and panel pillars (fig. 4)	44	26
Coal lost in oil or gas-well pillars	None	..
Coal lost under buildings, railroads, and boundaries	Included in above	..
Coal lost in handling and preparation, underground and surface	4	..
Coal lost due to rolls, thin or dirty areas, and streams	3	..
Total loss, per cent	51	26

wide would be left. One thousand feet would be 5 per cent of four miles. Even if from a conservation standpoint the coal should be mined clean under agricultural land, there will undoubtedly be some places where this could not be done. For instance, where pillars are left under railroads and hard-surfaced roads, there might be left a three-cornered piece inside them which should be supported. Assuming that pillars could not be pulled under 20 per cent of the minable area, and assuming that the loss in preparation would be 7 per cent, there would still be possible an extraction of 75 per cent, which would be 26 per cent more than is at present being saved.

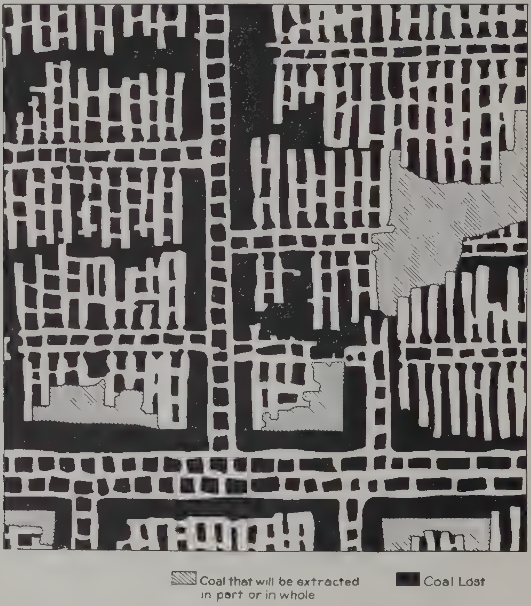

Fig. 4. Section of mine workings in Sangamon County showing pillars not extracted.

ACTUAL EXTRACTION

One company's general manager considers it questionable whether the district is getting 50 per cent of the coal. This operator has six mines in both seams.

Another company states that at two of its mines in No. 6 bed they get 50.5 per cent and 55 per cent, respectively, and at one mine in No. 5 bed they get 53.3 per cent.

At seven mines of another company in Sangamon County they get an average extraction of 48.12 per cent.

CONCLUSION

This district has been reported upon separately because the question of surface subsidence injuring very valuable agricultural land is the condition determining the method of mining. It is realized that from a practical standpoint it would be exceedingly difficult to get the farmer to permit all the coal to be taken out from under his land, but on the other hand, if an average of 5,000 tons of coal is left by the operator which he could mine by paying for the land at a cost of $300 per acre, it would be only 6 cents a ton for the coal that is lost, or 3 cents on his total tonnage. His saving in cost of operation would be several times this, and he would still have, in most cases, good land left.

COAL LOSSES IN THE SOUTHERN ILLINOIS FIELD, INCLUDING DUQUOIN AND MURPHYSBORO FIELDS

INTRODUCTION

These fields include the counties of Williamson, with 50 shipping mines producing 10,784,752 tons; Franklin, with 26 mines and 12,723,000 tons; Jackson, with 8 mines and 1,164,154 tons; the eastern part of Perry County with 11 mines and 1,740,000 tons, and the southeastern part of Washington County, with one mine producing 25,300 tons. This tonnage is taken from the report of the Illinois Department of Mines and Minerals for the year ended June 30, 1921. Four trips were made underground in this field, and specific data were obtained on a total of 31 mines producing 13,500,000 tons. General data were also secured on a number of other mines.

The coal being mined in this district comes from No. 6 bed of the Illinois Geological Survey, with the exception of 440,000 tons in Jackson County, which comes from No. 2 bed, as will be more fully discussed later in this report. No. 6 bed varies from 4 to 14 feet in thickness, and averages 9 feet. It is a good grade of coal, and the only persistent impurity is the so-called "blue band", which varies from a fraction of an inch up to 2 inches, and occurs at approximately 18 inches from the floor. The other bands of impurities are not regular, and consist of thin partings of sulphur or mother coal. The bed lies nearly level, with the exception of the western part along the Duquoin anticline, where it frequently dips 6 per cent or more. Also along the Duquoin anticline there is some faulting with displacements sometimes as high as 35 feet; and in Williamson and Franklin counties there is a little faulting with displacements of a few inches to a few feet.

CHARACTER OF ROOF AND FLOOR

In most places in this area the immediate roof over the coal is shale or "slate", and varies in strength from very weak to firm, but as a rule is considered as a weak roof. In some places the shale grades into so-called soapstone, which is unusually difficult to hold up with timbers. In Williamson County and southern Franklin County the shale usually contains more sand, so that the roof is generally a little stronger than in the rest of Franklin County. Above the immediate roof there is the so-called "cap-rock", or limestone, which is a hard stratum of rock varying considerably in thickness. This cap-rock in some places lies close to the top of the coal bed, and at other places it is 25 feet above the coal, and in a few places it is thought to be absent altogether. Where the cap-rock directly overlies the coal it makes an excellent roof, but the known area of such occurrences is so small that it is negligible. Owing to the fact that roof coal is left up over a large part of the workings, the exact nature of the roof is not so well known as would be the case otherwise.

The floor below No. 6 bed is of fire clay from a few inches to many feet thick, probably averaging 4 to 6 feet. Below the fire clay there is usually a harder rock stratum.

The cover varies from a few feet near the outcrop in Williamson County, to over 600 feet towards the north end of the field; and it probably averages 300 feet.

METHOD OF MINING

Most of the coal comes from mines using the room-and-pillar, panel system, but there are a large number of mines, especially in Williamson County, which use the straight room-and-pillar system. Two mines in this county were found to have the rooms 20 feet wide with 40-foot centers, with rooms 250 to 300 feet long. The entries were 12 feet wide on 37-foot centers. Another mine has rooms 21 feet wide on 40-foot centers, with entries 12 feet wide on 30-foot centers. Another mine has rooms 23 feet wide on 36-foot centers. In Franklin County, where the cover is greater, one mine 250 feet deep employs the panel system, with rooms 24 feet wide on 40-foot centers. Another mine 450 feet deep has 24-foot rooms on 45-foot centers, and the rooms are 250 feet long. This mine is operated on the panel system, and it has been found that the rooms can all be completed and the inside ends of many pillars extracted before a squeeze occurs. An adjoining mine uses 24-foot rooms on 40-foot centers, and seldom is able to get rooms driven up before a squeeze takes place.

The panel system of mining, which is in most general use, consists of driving the panel centers towards each other, and leaving a 20-foot pillar between them. There are 30 rooms—that is, 15 on each side of each panel entry—which would make 60 rooms to the double panel. Barriers or side pillars along the cross entries are 100 feet or 110 feet. At several mines pillar pulling has been done, but usually only to a very small extent, because as a rule the pillars are too thin to be extracted.

CALCULATION OF COAL LOSSES

Figures for a typical mine in Franklin County, when calculated according to the actual dimensions of the working places, gives a loss of 45½ per cent in the pillars, of which about 12 per cent is in the barrier pillars, and a little over 20 per cent in room pillars and room stumps. No attempt is made to save any of these pillars except the inside ends, which have been considered as saved in this calculation. The roof coal is all left up at this mine, and it amounts to 14 per cent of the thickness of the bed, or about 8 per cent of the total coal. To this there should be added about 3 per cent for loss in handling and preparation, giving a total loss of 56½ per cent.

At a mine in Williamson County, where straight room-and-pillar mining is employed, the actual dimensions indicate a loss of 40 per cent in pillars; but only about a third of the top coal is lost, the remainder being taken down after the rooms are completed. At this mine the loss in top coal is only 3 per cent, and if 3 per cent is added for loss in handling, the total loss will be 46 per cent.

At one mine in Jackson County, which employs the straight panel system with 20 rooms to a panel, the rooms being 22 feet wide and the pillars 23 feet wide, the loss in pillars figures 57 per cent, and the loss in top coal, 10 per cent, which gives a total loss of 70 per cent, including 3 per cent for loss in handling.

The loss of coal due to faults is nothing in the majority of the mines, but may be 5 per cent in others, although it probably does not average more than 1 per cent over the entire field. There are also very few reservations except near the outcrop, where the cover is shallow, though occasionally in other parts of the field, reservations are left under certain farmhouses or cemeteries, but as near as the writer could determine, these would not average over 0.5 per cent.

Actual Extraction

Fortunately there are a number of actual calculations available, made by different engineers, which furnish good data on the recovery in this field. For instance: (1) the average of three mines in Williamson County is 56.59 per cent; (2) the actual extraction of another company from two mines in the same county is 61 per cent; (3) careful planimeter measurements made of three mine maps gave an average extraction of 45.4 per cent, of which 5½ per cent was due to top coal and 2½ per cent to coal left under ponds and as boundary pillars; and (4) three mines in this county gave 50 per cent. Giving each mine the same weight, the average extraction for the 11 mines is 52½ per cent. In Franklin County, two mines of one company give an average recovery of 49½ per cent. The writer was also able to secure other information regarding three mines, one of which had an extraction of 42.7 per cent; another, 39½ per cent; and another, 31.9 per cent. There are also some reliable data given in Bulletin 100[3] of the University of Illinois. This was the work in charge of the late H. H. Stoek, who had four engineers carefully taking measurements under his direction. On account of the care with which this work was done, the following has been abstracted from the publication mentioned:

"The coal mined is the No. 6 bed of the State Geological Survey classification. Measurement of 113 sections taken in twelve of the largest mines in the county gave an average thickness of 9.2 feet of coal, the average minimum thickness for the same twelve mines being 8 feet, and the average maximum thickness 10.64 feet. The blue band, which is characteristic of No. 6 bed, varied from ¼ to 2 inches in thickness, and its average distance from the floor was 21.5 inches. Owing to the difficulty of keeping up the shaly material above the coal bed, the top coal is almost generally left as roof protection, and up to the present time, very little of this top coal has been recovered, although some operators are expecting to recover it at a later date in connection with pillar drawing. In one of the twelve mines from which the data were obtained, top coal was not left in the rooms. This, however, is exceptional practice, the average thickness of the top coal left in the twelve mines being 1½ feet. The average thickness of coal mined was 7.46 feet, and the average tonnage per acre to January 1, 1916, was 6,627 tons. This is equivalent to 40.7 per cent extraction, if it is assumed that all the 9.2-foot bed is available for shipment, or to 41.6 per cent if it is assumed that the blue band and refuse discarded in the loading, or 0.2 foot, is deducted from the thickness of the bed. A very careful estimate for each of the twelve mines noted, made by dividing the total amount of coal in the area mined up to January 1, 1916, into the actual shipments since the mine began operating, gave percentages of extraction varying from 37.7 to 49.5, or an average of 41.4 per cent."

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[3] Young, C. M., Percentage of extraction of bituminous coal with special reference to Illinois conditions: Engineering Experiment Station Bull. 100, p. 46, 1917.

CONDITIONS IN JACKSON COUNTY, INCLUDING NO. 2 BED

In Jackson County, 1,640,154 tons of coal was produced in 1921, of which approximately 110,000 tons came from four mines working No. 2 bed, these mines being situated in what is known as the Murphysboro district. The remainder of the production came from No. 6 bed. No. 2 bed is from 5 to 7 feet in thickness, and about half of the tonnage came from where the entire bed was being worked, but some top coal was left in the entries. The remainder of the tonnage came from a lower bench only of No. 2 bed, because the bed splits into two benches, the bottom of which is 3½ to 4 feet thick and the top bench 2 feet thick. The band between the two benches varies from

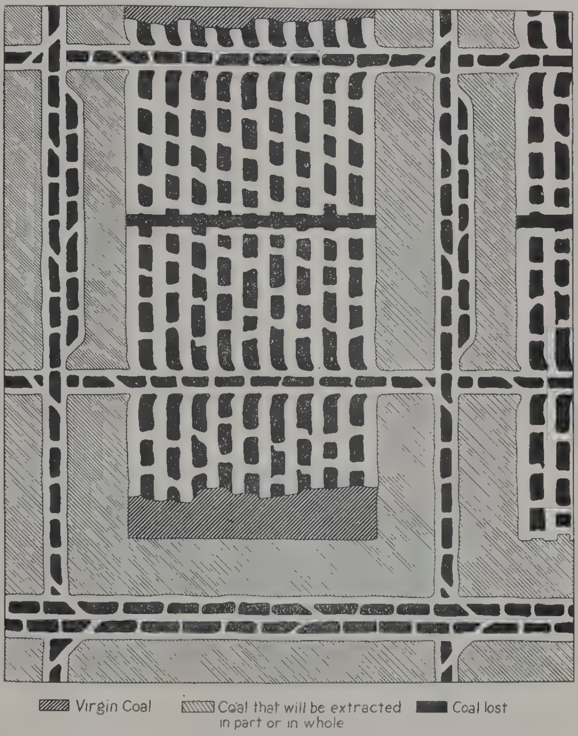

FIG. 5. Section of mine workings in Jackson County showing pillars not extracted.

6 inches to 26 feet. This means that where the lower bench only is worked, the top bench is lost, but of course it could not be saved where the parting is very thick. No mines were visited in this field, but this information is gathered from a bulletin of the Illinois Coal Mining Investigations,[4] by S. O. Andros, and from Frank Rossbottom, the State mine inspector in this district. It can be readily seen that because some top coal is lost, and there is very small tonnage, tc include the No. 2 bed in this report cannot appreciably affect the results. One company states that it gets an extraction of 50 per cent from its mines in No. 2 bed in Jackson County.

Average Coal Losses

In Franklin County the recovery figures are all around 41 or 42 per cent, with the exception of one company; and owing to the fact that the mines in this county are not very old, and the low figures given were very carefully taken, they are probably correct. In Williamson County most of the figures are over 50 per cent, but at the small mines the extraction is almost as low as in Franklin County, and there are many small mines. Squeezes are also common in all of the counties. Taking everything into consideration, the average recovery for the area is about 47 per cent, including about one-fourth of the barrier-pillar coal on the retreat, which may be saved.

Table 7.—*Summary of coal losses in southern Illinois*

Reason for loss	Percentage of total marketable coal lost in area worked	
	Total loss	Avoidable loss
Coal left as roof and bottom coal	7	..
Coal lost in room, entry, and panel pillars (fig. 5)	41	36
Coal lost in oil or gas well pillars	None	..
Coal lost under buildings, railroads, and boundaries	1	..
Coal lost in handling and preparation, underground and surface	3	..
Coal lost due to rolls, thin or dirty areas, and streams	1	..
Total loss, per cent	53	36

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[4] Andros, S. O., Coal mining practice in District II: Ill. Coal Mining Investigations Bull. 7, 1914.

AVOIDABLE LOSS

The land in this district has little surface value, except where close to a growing town. Some of it is absolutely worthless, and very little of it is worth more than $50 an acre. There is little reason to suppose that pillars could not be pulled in this field and at least 83 per cent of the coal saved. This estimate does not involve removal of the top coal.

COAL LOSSES IN SALINE COUNTY

Introduction

This report covers the mining of No. 5 coal bed in Saline County. There were 23 shipping mines listed in the report of the State Department of Mines and Minerals for the fiscal year ending June 30, 1921, their total production being 4,245,132 tons.

One trip was made underground, and figures were obtained from operators representing the production of nearly 2,000,000 tons. The bed ranges in thickness from 4 to 7 feet, averaging a little less than 6 feet. All mining is done by room-and-pillar methods, and in most mines the panel system is employed. Most of the mines are opened by shafts, varying in depth from 65 to 505 feet, with an average of probably 235 feet.

Characteristics of the Seam

From observations in the mine visited, and from data secured from other operators, it is evident that the roof conditions over this coal bed are, as a rule, excellent. The roof is gray, sandy shale, and stands up remarkably well. The seam is clean, comparatively speaking. Occasionally a thin streak of "draw-slate" comes in between the coal and the good top. The floor is of fire clay, which in places contains sand, and like most of the floor in the Illinois mines, heaves when wet. The floor is also very rolling, frequently making it necessary to have steep grades on the entries, or else run them around the high spots.

Dimensions of Working Places

Some operators drive wide entries of 18 feet or more, leaving about 30 feet of pillar between, and others drive entries only 12 feet wide. Rooms are from 24 to 28 feet wide, and pillars are 12 to 18 feet thick. Sometimes room-necks are narrow, but more frequently the rooms are started about 20 feet wide, and gradually widened to their full width. Room crosscuts are 18 to 20 feet wide.

Losses of Coal

From calculations made at the mine visited, which was said to be an average of the district, the loss in pillars, including 75-foot barrier pillars, amounts to 38 per cent. Owing to the cleanliness of the seam, the coal thrown back into the gob does not amount to over 3 per cent. Unfortunately the beds are cut by numerous faults, with throws of from a few inches to over 100 feet. It is difficult to arrange the plan of a mine to get all the coal along these faults, and also the roof is bad near them. One operator claimed that they had lost no coal on account of faults as yet, whereas the map of another mine showed a loss of about 10 per cent. Probably 5 per cent represents an average loss.

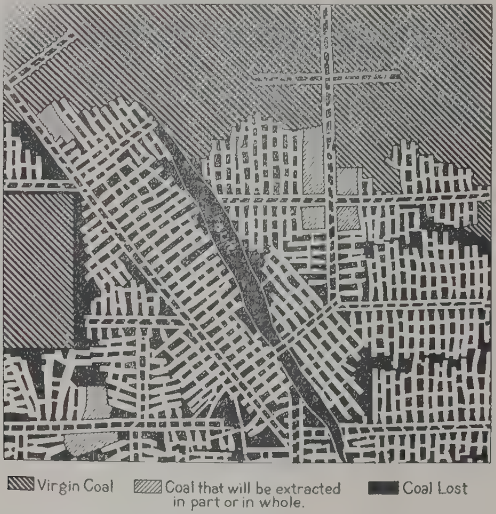

Fig. 6. Section of mine workings in Saline County showing pillars not extracted and coal lost because of irregular workings and due to displacement faults.

Actual figures of extraction, as reported to the writer, were as follows: (1) 57.06 per cent; (2) 3 mines, 51 per cent, 51.5 per cent, and 53.3 per cent; (3) 51 per cent.

AVOIDABLE LOSS

The conditions in this field, as far as the coal bed is concerned, are ideal for pillar pulling. From the standpoint of surface conditions, the land is valuable for farming, but not so valuable as that in the Springfield district. Also it is more broken, and very little, if any, is tilled. There are fewer towns and fewer railroads. The land is occasionally flooded by high water in Ohio and Wabash rivers, but the mining companies could well afford to build levees as high as the ground would subside from pillar drawing, if such would be necessary. Taking everything into consideration, an extraction of 85 per cent ought to be secured in this field.

LOSS IN OVERLYING SEAMS

The No. 6 bed is about 70 feet above No. 5 in this area, and is of workable thickness. As mining is now carried on, No. 6 seam will not be affected except where squeezes occur, or where caves in rooms extend up to it, which is rare. On the whole, it is the writer's opinion that very little coal in No. 6 bed is at present being lost, but information either for or against this conclusion could not be obtained.

TABLE 8.—*Summary of coal losses in Saline County*

Reason for loss	Percentage of total marketable coal lost in area worked	
	Total loss	Avoidable loss
Coal left as roof and bottom coal................	None	..
Coal lost in room, entry, and panel pillars.........	38	31
Coal lost in oil or gas-well pillars.................	None	..
Coal lost under buildings, railroads, and boundaries	Included in above	..
Coal lost in handling and preparation, underground and surface	3	..
Coal lost due to rolls, thin or dirty areas, and streams[a] (fig. 6).............................	5	..
Total loss, per cent.........................	46	31

[a] Includes coal along faults.

COAL LOSSES IN THE DANVILLE DISTRICT

INTRODUCTION

The Danville district has 7 mines in No. 6 bed and 5 mines in No. 7 bed, but by far the largest production comes from the former. It includes Vermilion County only, and has a total production of slightly over 3,000,000 tons, of which about 450,000 tons come from strip or open-cut mines.

No trips were made underground while studying this field, but operators were interviewed who mine over half of the total tonnage.

The characteristics of the beds have been described by S. O. Andros in a bulletin of the Illinois Mining Investigations series,[5] as follows:

"In this district all the large outputs are produced from the No. 6 bed of the Illinois State Geological Survey correlation.

"The chief characteristic of the No. 6 bed, which averages 6 feet in thickness, is the presence of a blue band which divides it into upper and lower benches. This blue band varies from soft dust to hard gray shale, and occurs about 2 feet above the floor. In addition to this blue band there are several shale and sulphur bands of variable horizontal and vertical extent.

"The roof over No. 6 coal is variable. Near Danville the immediate roof is a grayish black shale about 6 feet thick. This shale, lying between the coal and the cap-rock of dark-gray nodular limestone makes an easily supported roof. In the vicinity of Westville and Georgetown the immediate roof is usually a gray shale, which shows no distinct bedding, has little cohesion, falls in conchoidal masses, and is extremely difficult to support. Further, stringers of coal extend from the bed proper into the roof material, and render the roof more difficult of support. In isolated cases there are 3 to 4 inches of black shale between the coal and the gray shale which forms the cap-rock. Whenever this black shale is broken, air and moisture disintegrate the gray shale cap-rock, and the roof becomes insupportable.

"In all parts of the Danville district the floor is a soft fire clay.

"The No. 7 bed varies in thickness from 2½ to 5½ feet, and averages 5 feet. The coal has two benches separated by a clay band 1 inch thick, which persists through the bed from 6 to 8 inches above the floor. The two benches present no great difference in appearance or in physical character, except locally, where the top bench is harder and has a brighter luster. The No. 7 bed generally has slightly more impurities than the No. 6 bed, higher volatile matter, lower fixed carbon, and higher sulphur content as shown by analyses of 31 face samples in No. 6 and of 18 face samples in No. 7. The bands of pyrites occur persistently at a height of 20 to 26 inches above the floor, and sulphur balls or nodular concretions of pyrite are present in such quantity as to make profitable their separation from the coal by hand picking in the mine, and by a further separation on the surface in rotating cylinders.

"In both beds in the district there are numerous rolls, called 'faults,' or 'horsebacks' by the miners. These rolls appear to have been due to unequal settling of the coaly matter and the necessary readjustment of the roof materials, during the formation of the coal. In many cases the roll entirely displaces the coal.

"The mines in District VIII are shallow, and the deepest mine does not exceed 300 feet."

---

[5] Andros, S. O., Coal mining practice in District VIII (Danville): Ill. Coal Mining Investigations Bull. 2, 1914.

METHOD OF MINING

Room-and-pillar methods of mining are employed, with some efforts to divide the workings into panels. One of the largest companies uses 24-foot rooms driven on 30-foot centers. Some room pillars are drawn, but over the entire field the amount of coal thus recovered amounts to very little. Some of the companies try to protect the surface where it is agricultural land, but others do not, as they do not have to pay damages for surface subsidence. Under the towns and railroads the work is carried on according to the usual method, except that more care is taken to leave sufficient pillars to avoid squeezes. In the north end of the district, along Little Vermillion River, a great deal of coal has to be left under branch streams which flow into the river. However, this coal being of shallow depth, it can be recovered in a large part by stripping operations.

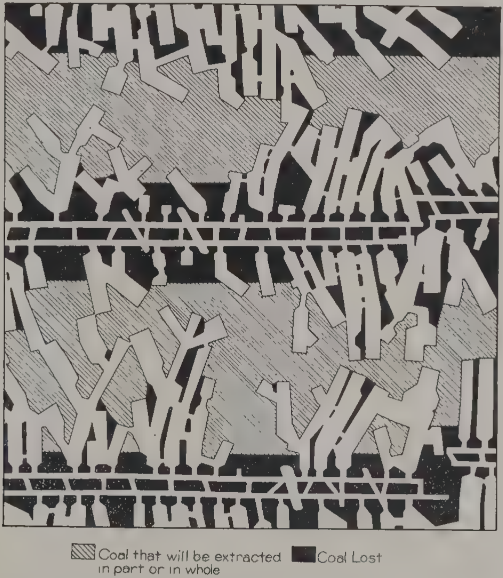

FIG. 7. Section of mine workings in Vermilion County showing coal lost because of irregular spacing and direction of rooms.

LOSSES OF COAL

One company producing about 1,400,000 tons per year reported that its extraction is from 55 per cent at the smaller mines to 65 per cent at the larger mines, and that 15 per cent of the total loss is due to rolls and faulty conditions. Another company figures on an extraction of 53.43 per cent. Under ordinary conditions, with 24-foot rooms and 6-foot pillars, the loss in pillar coal would be 32 to 35 per cent, and judging from experience in the Panhandle and Belmont fields of West Virginia and Ohio, the writer does not believe that the mines in the Danville field can get 65 per cent of their coal when their faulty conditions are considered. Without further information the writer can not see how the extraction in this field can be over about 57 per cent in the underground mines, divided as shown in Table 9.

TABLE 9.—*Summary of coal losses in the Danville district*

Reason for loss	Percentage of marketable coal lost in area worked	
	Total loss	Avoidable loss
Coal left on roof and bottom	None	..
Coal lost in room, entry, and panel pillars (fig. 7)	32	23
Coal lost in oil or gas-well pillars	..	..
Coal lost under buildings, railroads, and boundaries	Included in above	..
Coal lost in handling and preparation, underground and surface	4	..
Coal lost due to rolls, thin or dirty areas, and streams	7	..
Total loss, per cent	43	23

AVOIDABLE LOSS

Owing to the fact that some of the companies have the surface rights, and also that the county has fewer towns and is more rolling in contour, they should get a higher extraction than is possible in the Springfield district. The question of possible recovery and the means of arriving at it have been discussed in the Springfield report, and based on the same reasoning possible recovery in the Danville district should be 80 per cent.

PUBLICATIONS
ILLINOIS MINING INVESTIGATIONS

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Bulletin 1. Preliminary report on organization and method of investigation, 1913.
Bulletin 3. Chemical study of Illinois coals, by S. W. Parr, 1916.
Bulletin 10. Coal Resources of District I (Longwall), by G. H. Cady, 1915.
Bulletin 11. Coal resources of District VII, by Fred H. Kay, 1915.
Bulletin 14. Coal Resources of District VIII (Danville), by Fred H. Kay and K. D. White, 1915.
Bulletin 15. Coal resources of District VI, by G. H. Cady, 1916.
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Bulletin 17. Surface subsidence in Illinois resulting from coal mining, by Lewis E. Young, 1916.
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Bulletin 28. Preliminary report on coal stripping possibilities in Illinois, by Harold E. Culver, 1925.
Bulletin 29. Coal resources of District III, by Harold E. Culver, 1925.
Bulletin 30. Coal losses in Illinois, by C. A. Allen, 1925.

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Bulletin 2. Coal mining practice in District VIII (Danville), by S. O. Andros, 1913.
Bulletin 4. Coal mining practice in District VII, by S. O. Andros, 1914.
Bulletin 5. Coal mining practice in District I (Longwall), by S. O. Andros, 1914.
Bulletin 6. Coal mining practice in District V, by S. O. Andros, 1914.
Bulletin 7. Coal mining practice in District II, by S. O. Andros, 1914.
Bulletin 8. Coal mining practice in District VI, by S. O. Andros, 1914.
Bulletin 9. Coal mining practice in District III, by S. O. Andros, 1915.
Bulletin 12. Coal mining practice in District IV, by S. O. Andros, 1915.
Bulletin 13. Coal mining in Illinois by S. O. Andros, 1915. (Complete resumé of all the district reports.)
Bulletin 91. Subsidence resulting from mining, by L. E. Young and H. H. Stoek, 1916.
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Bulletin 144. Power studies in Illinois coal mining, by A. J. Hoskin and T. Fraser, 1924.

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Technical Paper 190. Methane accumulations from interrupted ventilation, with special reference to coal mines in Illinois and Indiana, by H. I. Smith and Robert J. Hamon, 1918.
Technical Paper 246. Water-gas apparatus and the use of central district coal as generator fuel, by William W. Odell, 1921.
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Technical Paper 284. Coal and coke mixtures as water-gas generator fuel, by W. W. Odell, 1921.
Technical Paper 304. Water-gas tar emulsions, by W. W. Odell, 1923.
Technical Paper 330. Small hose streams for fighting mine fires, by L. D. Tracy and R. W. Hendricks, 1924.
Technical Paper 361. Cleaning tests of central Illinois coal, by Thomas Fraser and H. F. Yancey, 1925.

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, *Director*
DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

Cooperative Mining Series

BULLETIN 31

COAL STRIPPING POSSIBILITIES IN SOUTHERN AND SOUTHWESTERN ILLINOIS

BY

G. H. CADY

ILLINOIS MINING INVESTIGATIONS

Prepared under a cooperative agreement between the Illinois State Geological Survey Division, and the Engineering Experiment Station of the University of Illinois

AUG. 26TH 1818

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1927

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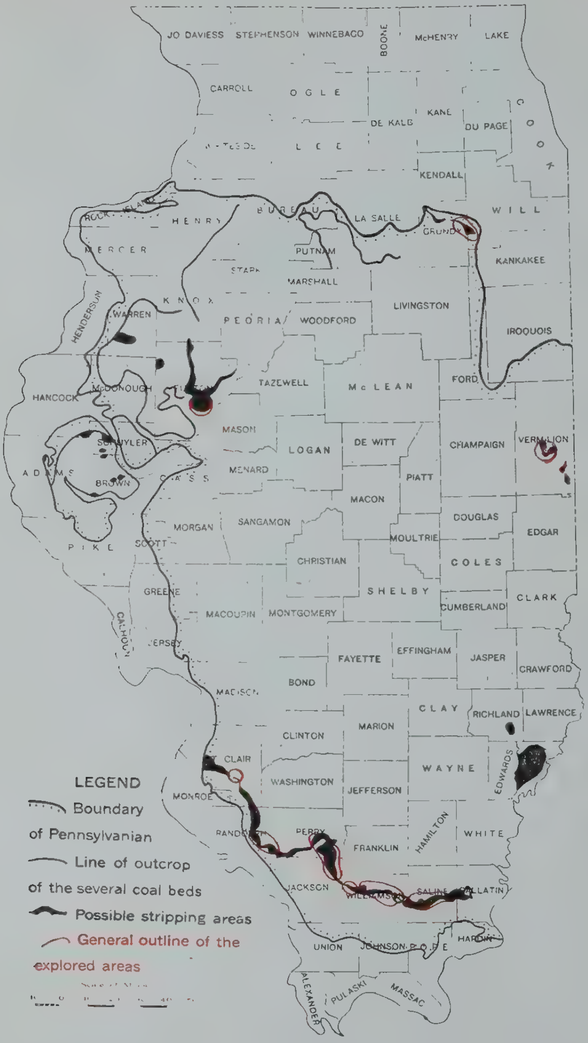

Fig. 1. Map of Illinois showing the locations of possible stripping areas. In most of the areas outlined in red, exploration is restricted to a single bed. The extent of exploration in Fulton County is not known.

COAL STRIPPING POSSIBILITIES IN SOUTHERN AND SOUTHWESTERN ILLINOIS

By G. H. Cady

PART I

INTRODUCTION

General Statement

In 1925 the Illinois State Geological Survey published a preliminary report on coal stripping possibilities in the State.[1] This report was prepared at a time when the area of coal being stripped and the production of strip coal were undergoing notable expansion. In 1924 the production of strip coal was 1,503,542 tons, whereas in 1925 it was 3,053,723 tons. Since the summer of 1925, no additional large strip pits have been opened but there has been an appreciable increase in production as shown in Table 1.

Although strip-mine production has not greatly changed since 1925, a continued interest in stripping as a possible source of coal is manifest in the large amount of exploratory work that has been carried on in this interval in the areas designated in the preliminary report as suitable for investigation. Some of the exploration was begun before the report was published but most of it is of a later date and has been located in accordance with suggestions contained in the bulletin. As a result of test drilling, large tracts have been explored in northern Illinois, particularly in Grundy County, and in southern Illinois along the outcrop of No. 6 coal from Millstadt, St. Clair County, east into Saline County, and along the outcrop of No. 5 coal in Williamson and Saline counties. The areas which as a result of drilling completed or now in progress can no longer be included in the category of untested regions are indicated in figure 1 which also shows the location of possible stripping areas in the State as described in the preliminary bulletin.

To meet continued calls for information the present bulletin, giving additional data in regard to specific untested areas, as of May, 1927, is issued. Some of the areas selected for description are chosen because new and more detailed information has become available as a result of special areal mapping in the regions concerned, others because they lie adjacent to regions already tested. Such regions remain untested possibly because of great uncertainty in regard to the position of the border of the coal bed. Since there can be no doubt but that the border actually extends across these areas, the Survey wishes to contribute such information and opinions as it has in regard to the position of this border or outcrop on a map of somewhat larger scale than was published in the earlier report. The special areas described in this bulletin are located along the outcrop of No. 5 and No. 6 coals in southern Illinois. (See fig. 2.)

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[1] Culver, H. E., A preliminary report on coal stripping possibilities in Illinois: Illinois State Geol. Survey, Cooperative Mining Series Bull. 28, 1925.

Company	County	Production Fiscal year ending June 30, 1924 *Tons*	Fiscal year ending June 30, 1925 *Tons*	July 1 to Dec. 31, 1925 *Tons*	1926 *Tons*
1 *b* Tiger Coal Mining Co.	Fulton	3,525	4,440		
2 *b* United Electric Coal Co., No. 9	Fulton, Cuba (P. O.)	51,950	489,366	362,229	822,129
3 *b* Buckheart Coal and Mining Co.	Fulton, R. F. D. No. 6, Canton	5,276			5,518
4 Saline Creek Coal Co.	Gallatin		24,177	30,434	
5 *b* Black Servant Coal Co.	Jackson, Elkville	171,845	470,076	210,352	431,211
6 Forsyth Coal Co.	Jackson, De Soto			33,572	317,518
7 Scott-Smith Coal Co.	Perry	112,100			
7 Perfection Coal Co.	Perry, Du Quoin		90,000	69,790	189,990
8 Pyramid Coal Co., No. 2	Perry				40,594
9 *c* Gayle Coal Co.	Perry, Du Quoin		251,079	156,498	327,555
10 Solar Coal Co.	St. Clair, Freeburg			74,508	157,937
11 *b* Harrisburg Coal Mining Co., No. 2	Saline, Harrisburg	216,978	224,255	125,402	200,279
12 Yankee Branch Coal Co., No. 1	Vermilion, Georgetown	38,046			18,320
13 Chicago Collieries Co., No. 4	Vermilion	163,303	124,611	102,082	
14 I. I. Coal Co.	Vermilion	3,800			
15 United Electric Coal Co., No. 1	Vermilion, Danville	205,487	467,588	154,098	299,187
16 United Electric Coal Co., No. 4	Vermilion	130,297	180,097	93,184	30,588
17 United Electric Coal Co., No. 5	Vermilion	121,896	95,953	58,538	23,027
18 United Electric Coal Co., No. 12	Vermilion				128,030
19 Yankee Branch Coal Co.	Vermilion		38,800	30,800	
20 *b* Coal Belt Coal Co.	Williamson	15,366			
20 Van Hoos Coal Co.	Williamson		3,000		
21 Mammoth Coal Co.	Williamson, Marion	29,271	61,370	15,451	31,791
22 Prosperity Coal Co.	Williamson		1,336	484	
23 *b* Prosperity Coal Co., No. 1	Williamson	3,698			
24 *b* Prosperity Coal Co., No. 2	Williamson	5,704			
25 *b* Quaker Mining Co., No. 1	Williamson	105,000			
25 Worth-Huskey Coal Co., No. 1	Williamson		106,455	47,151	
26 *b* Quaker Mining Co., Fuel mine	Williamson	120,000			
26 Worth-Huskey Coal Co., No. 2	Williamson		144,209	64,984	
27 *d* Huskey Coal Co.	Williamson, Cambria				252,947
28 Pyramid Coal Corp., No. 1	Williamson, Marion				313,508
29 *c* Pyramid Coal Corp.	Williamson		276,911	157,797	
Total strip coal production		1,503,542	3,053,723	1,787,354	3,590,129

*a*From tables of Illinois Annual Coal Reports, 1924 and 1925, and supplied by Illinois Department of Mines and Minerals, 1926.
*b*Not operating prior to June 30, 1923.
*c*Not operating prior to June 30, 1924.

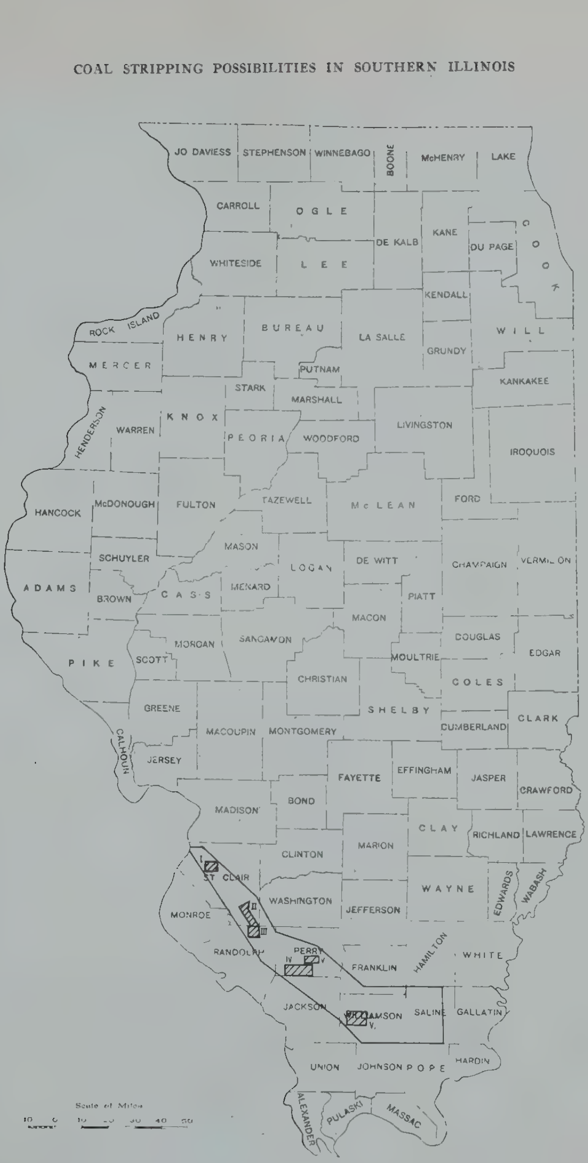

Fig. 2. Map of Illinois showing locations of areas described in this report.

FACTORS BEARING ON THE AVAILABILITY OF A DEPOSIT

In the preliminary bulletin it was stated that "a commonly accepted minimum for the thickness of the coal is 48 inches for a commercial operation", but other factors may considerably reduce this in certain cases. It is noteworthy that in areas recently explored in Grundy County the coal in general has a thickness of not more than 42 inches; in fact the average thickness of No. 2 coal in the Coal City-Wilmington region is generally regarded as not more than 37 inches. Although detailed information in regard to the thickness of the coal discovered by recent drilling has not been conveyed to the Survey, there is no reason to believe that the coal exceeds the average thickness of the general region. Inasmuch as the facts were known in regard to the probable thickness of the coal when the prospecting was undertaken, it is evident that a thickness of 40 inches was regarded as above the minimum for commercial operation, provided other conditions were particularly favorable.

There seems to be a general opinion among operators that the ratio of the thickness of the coal to the thickness of the overburden should not average more than 1 to 8. Since the cost of excavation increases at a greater rate than the increase in depth, at least as the thickness of the overburden makes necessary two operations; possibly a somewhat larger ratio may hold for thin coals than for thick coals. Local conditions enter so largely into the cost of stripping that no general rule can be stated except that the profitable extraction of coal having a heavy overburden is possible only when other conditions, such as the character of the overburden, machinery, relation to markets, etc., are particularly favorable.

The decrease in the importance of hard layers of rock as deterrents to the stripping operation has been mentioned by Dr. Culver.[2] He states: "more recent work has demonstrated that the shale and 'slate' do not seriously interfere with operations, and in places, even a 5-foot bed of massive limestone has been handled satisfactorily after shooting." It can now be said that operations appear to be successful in which the thickness of the limestone is 5 to 7 feet. Operations have recently been started near Duquoin in a region where preliminary drilling indicates that limestone of even greater thickness than 7 feet must be moved to reach the coal. It is anticipated that the limestone recovered will constitute a by-product of the operation, the sale of which will largely cover the cost of its removal. Inasmuch as a heavy limestone cover characterizes No. 6 coal west of Duquoin, the prospects seem to be good for the development of a large crushed-stone industry in this portion of the State. Since natural sources of ballast and road material are meager, the local market for the crushed stone probably will be good. Unless the limestone can be marketed at a price that will compensate the cost of removal, it is doubtful whether the coal can be recovered in large areas in southern Illinois west of Duquoin even though the cover is not more than 30 feet thick, because much of this cover is limestone.

---

[2] Culver, H. E., A preliminary report on coal stripping possibilities in Illinois: Illinois State Geol. Survey, Cooperative Mining Series Bull. 28, p. 10, 1925.

The size and capacity of mechanical shovels used in large-scale stripping operations are undergoing changes which necessitate continual revision of the estimate of removable overburden. On the basis of the estimates made in Cooperative Mining Series Bulletin 28 of the Illinois State Geological Survey, of the extent of area in Illinois within which coal is available by open-cut methods of mining, manufacturers have been designing machines with an enlarged capacity, particularly with respect to the handling of limestone beds such as are found above the coals in southern Illinois. It remains to be demonstrated whether or not efficient operation is possible with shovels with a capacity larger than about 8 yards. It is reported that a much larger shovel is to be installed in one of the recently opened pits near Duquoin. If the report is correct much interest will attend the performance of this machine particularly as the limestone overburden is unusually heavy.

Economic Factors Determining the Success or Failure of Stripping Operations

In the earlier report on coal stripping possibilities it is possible that too little attention was given to the conditions which determine the success or failure of a stripping operation other than those dependent simply upon the thickness of the coal and overburden. It is the desire of the Survey to encourage the development of the resources of the State but only as conditions warrant such development. A word of caution needs to be spoken for the sake of those who regard stripping operations as unattended by much risk. The following pertinent statement was recently made:[3]

"Coal stripping is rather a hazardous business. The apparent simplicity of the proposition is an incentive that often governs those who develop such properties. The cost of the plant ready to produce coal is less than that for a shaft mine; on the other hand the life of a stripping plant is much shorter than that of a shaft mine, and for this reason the stripping plant often proves more expensive in the end. The stripping method requires less labor than a shaft mine to produce an equal amount of coal when the conditions are favorable for stripping. Weather, however, is a factor of serious importance, as a rainy spell may cause very serious financial loss."

---

[3] Bement, A., The Illinois coal field, Manuscript report for the Illinois Geological Survey, 1927.

The difficulties that enhance the risk of strip mining in Illinois arise largely from the topographic conditions where the stripping must be carried on. In southern Illinois stripping must usually, if not always, be carried on in areas of low relief. The pit in general lies below the drainage level and the spoil in the first excavation must be piled on the surface. After excavation has proceeded for some time the spoil can be piled back into the part of the pit from which the coal has been removed. Where the overburden is heavy the waste cannot be dumped at a safe distance from the shovel in a single operation and an additional shovel or drag line is usually necessary to remove part of it to a greater distance. There is a natural desire to avoid the use of a second shovel if possible. By so doing there is a very great danger that the shovel making the excavation to the coal will find itself between two treacherous banks of earth and, in the event of rain, even buried in slides from one or both sides.

Wise choice of equipment both in kind and amount will very largely determine the outcome of a stripping venture. A study of the statistics of stripping operations indicates that experience is of the same importance in this sort of operation as in other sorts of mining. The largest and most successful pits are those that have been longest in operation or are operated by experienced companies. So far as the writer is aware there are in Illinois no areas where coal can be stripped on a large scale in an operation unattended by much financial risk.

In a report of this kind emphasis is naturally placed upon large-scale operations. In fact it is only as equipment is introduced capable of lifting cheaply a burden 8 to 10 times the weight of the coal, that most of the coal at shallow depth becomes available for recovery by open-cut methods. On the borders of areas where stripping is possible, however, there are usually small bodies of coal under particularly shallow cover available for recovery by the simple methods of team and scraper excavation. Small pits of this kind have been in operation in various parts of the State continuously. They represent a common source of cheap coal during the summer months, at least, for the immediately surrounding rural district. Like local mines they are of relatively small importance in comparison with the production of the State as a whole, but may be of considerable local importance. It is quite probable that within the areas described in this report there are places where under very shallow cover small bodies of coal exist suitable for recovery on a small scale. The 8,000 tons of coal in a 5-foot bed extending beneath an acre of land would be a sufficient supply for a rural community for a number of years.

RESTORATION OF THE WASTE LAND

The chief popular objection to stripping operations is directed against the unsightly and unredeemable piles of spoil that result from open-cut mining. That the land may have been of little value under cultivation is rarely considered. A 5-foot bed of coal has much more immediate value than the surface at even $100 an acre. Yet the destruction of a permanent potential resource represented by the soil for the sake of recovering and exhausting another resource, although it may be of greater immediate value, will always be popularly regarded as economically unsound. There is constant danger of the enactment of legislation against this method of mining coal particularly as the scale of the operations becomes increasingly large. It therefore behooves those interested in such operations to take some thought of the possibility of restoring the worked-over lands to cultivation. That the spoil could be distributed in less topographic confusion seems certain. Before any of the land can be rendered fit for cultivation it must first be restored to some resemblance to the original topographic form. It then becomes the problem of agronomists and botanists to determine the most suitable procedure for restoration of the soil and vegetation. The writer is of the opinion that the consideration of the matter of restoration of lands wasted by the large-scale stripping process cannot be indefinitely delayed.

PART II

UNEXPLORED STRIPPING POSSIBILITIES IN SOUTHERN ILLINOIS

Introductory Statement

The rise of the coal-bearing rocks toward the margin of the coal field in southern Illinois brings to the surface the important coal beds mined through shafts in St. Clair, Randolph, Perry, Jackson, Williamson, and Saline counties. This is a matter of particular interest to those searching for areas of coal suitable for open-cut mining. Three beds are mined by shafts in the southern part of the State, No. 6, No. 5, and No. 2. Of these, No. 6 is the most widespread. In fact it appears to be continuous entirely across the southern part of the State, and its outcrop is therefore also continuous. No. 5 coal is locally interrupted, if not entirely absent, west of Randolph county, and No. 2 coal cannot be identified along the outcrop of the coal-bearing beds west of Jackson County. The upper or No. 6 coal known as the Belleville or Herrin coal, is the most important coal bed in the State. It is very regular in thickness which varies from six to nine feet along its southern margin, and of good quality, so that particular interest is attached to facts relating to the position and character of its outcrop. The accompanying maps and descriptions are concerned mainly with conditions along the outcrop of No. 6 coal, although some consideration will be given to No. 5 coal in certain areas.

General Map of the Coal Outcrops in Southern Illinois

GENERAL STATEMENT

As a background for the discussion a map has been prepared (Pl. I) showing the outcrop of No. 6 coal from the Mississippi River bluff line near Belleville to the vicinity of Harrisburg, Saline County, and showing also the outcrop of No. 5 coal across Williamson and Saline counties. In the preparation of the map the outcrops were first plotted on quadrangle maps on a scale of about one mile to an inch with as great detail as was possible. The lines were then transferred to the smaller scale map of publication. The published map is on the same scale, four miles to the inch, as is the road map of Illinois published by the State Division of Highways, which was used as a base. The entire line of outcrop, or outcrops where two coals are mapped, possesses interest, because along it, if anywhere, will open-cut mining be possible in the southern part of the State.

CHARACTER OF THE OUTCROP

The word outcrop unfortunately suggests that the coal bed mapped actually comes to the surface of the ground and can therefore be traced by following the coal blossom. This, however, is not true, since it is only here and there that the coal actually comes to the surface or to the grass roots. The most common places of actual exposure are where streams have removed the usual covering. Not only the outcrops of the coal, but also the outcrops of any rocks are rare. Sandstones and limestones appear at the surface more commonly than do other rocks. In general the surface material consists not of rocks but of unconsolidated material deposited by glaciers, streams, and wind, and the rock surface may lie from a few inches to 100 feet or more below the surface of the ground. In general throughout Illinois, the rock surface possesses considerably more relief than the ground surface; particularly is this true in southern Illinois where the valleys are deeply silted. In tracing the outcrop of a coal bed one of course notes its position on the rock surface, hidden beneath a mantle of soil.

COMPARISON WITH EARLIER MAPS

For earlier maps published by the State Geological Survey showing the outcrop of the coals across the southern part of the State only a rough approximation to accuracy was claimed. The lines indicating the margins of the beds for the most part connected scattered points of actual outcrop, and the intervening position of the lines was determined mainly in accordance with existing knowledge of the topographic features, the known depth of the coal at points north of the outcrop and the supposed character of the dip between these points and the outcrop. Where the beds are nearly horizontal and the surface is likewise level or only gently sloping it was then, as it is now, impossible without test holes to delineate their margins with much accuracy. The accurate information in regard to surface configuration furnished by the topographic maps now available entirely across southern Illinois is of great assistance in projecting the probable position of an outcrop. In addition, more detailed information in regard to the general lay and position of the coal approaching the outcrop has become available and knowledge concerning the position of the outcrop has been increased by local exploration by the drill; consequently an outcrop map based upon such improved data has a much stronger claim for accuracy than earlier maps prepared from less abundant data.

RELATIVE ACCURACY OF DIFFERENT PORTIONS OF THE MAP

The information accumulated in the Survey files regarding the outcrop of the coals in southern Illinois relates unequally to the various positions along the margin of the coal beds; an equal degree of accuracy cannot, therefore, be claimed for all portions of the designated lines of outcrop. In general where the lines describe somewhat intricate and irregular patterns the knowledge concerning the position of the outcrops may be considered good; where the lines consist of open broad curves, generalization may be suspected. In any case it is probable that the line of outcrop is more irregular than is represented since the scale of the map does not permit the delineation of small irregularities such as probably exist. The claim for greatest accuracy is made for those regions where privately conducted exploration by the drill, and detailed field investigation by members of the Survey staff provide the most complete information, and particularly for the position of the outcrop of No. 5 and No. 6 coals across Saline and most of Williamson counties, and of the outcrop of No. 6 coal across the northwest corner of Jackson County, along the east side of Beaucoup Creek in Perry County, and in Randolph County from Sparta to Percy. Along these stretches the outcrop of the coal has been tested by drilling in fairly large blocks and in several places field investigation has revealed the position of all actual outcrops. From Pinckneyville westward nearly to Willisville and westward from the vicinity of Sparta to the vicinity of Belleville there are stretches where the outcrop has been very little tested and its position remains uncertain. The outcrop northwestward from Marissa was mapped at the time the New Athens quadrangle was geologically surveyed in 1911.[1] Knowledge of the position of the outcrop of No. 6 coal in that area has not greatly improved since that time, except for a small area near the open-cut of the Solar Coal Company between Freeburg and New Athens.

SPECIAL AREAS

This report is particularly concerned with those areas along the outcrop that appear suitable for investigation but have not yet been tested by the drill. The position of the more important of these is indicated on Plate I; they are numbered I to VI from west to east across the map. Larger scale maps of these smaller areas (Pls. II–VII) have been printed on thin paper on the same scale as that of the topographic maps issued by the U. S. Geological Survey[2] and by placing them in their proper positions over these latter maps the relation of the outcrop lines to the topography can be readily ascertained. Other smaller areas suitable for investigation exist here and there along the outcrop of the coals, and although they will be mentioned, the main purpose of the report is to describe the conditions obtaining with respect to occurrence of the coal in the six special areas.

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[1] Shaw, E. W., U. S. Geol. Survey Geol. Atlas, New Athens-Okawville folio (No. 213), 1921.

[2] Topographic maps are available at ten cents a copy. The following quadrangles are included within the area covered by this portion of the report:

Baldwin
Campbell Hill
Carbondale
Coulterville
Duquoin
Galatia
Harrisburg
Herrin
Marion
Murphysboro
New Athens
Pinckneyville
St. Louis
Waterloo
West Frankfort

General Characteristics of the Coals and Associated Rocks in Southern Illinois

AVAILABLE COALS

Within all the areas, except possibly I and II located in St. Clair County, two coals outcrop—No. 5 and No. 6. However, only No. 6 coal is mapped except in Area VI in Williamson County, because, although there seems to be no doubt as to the presence of No. 5 coal in Areas IV and V, and although it may be present beneath Area III, the position of the outcrop and depth of the lower coal have not been sufficiently explored to warrant delineation. Its presence beneath No. 6 coal along the outcrop of the latter in St. Clair County is improbable. Between St. Clair and Williamson counties the outcrop of No. 5 coal is indefinite. In the vicinity of Willisville and southwest of Sparta, Randolph County, there has been some drilling along the outcrop of this coal, but for the most part the territory southwest of the outcrop of No. 6 coal has not been much drilled and outcrops of the lower coal are rare. It is probable, however, that the outcrop of the lower coal lies in general within half a mile south of the outcrop of No. 6 coal since the coals west of the Duquoin anticline are commonly separated by only 25 to 30 feet of strata.

In Williamson and Saline counties where No. 5 coal is economically more important there is more detailed information in regard to its outcrop than there is farther west. Even in these counties the mapping is not of uniform accuracy. Eastward from New Denison, that is across Ranges 4, 5, and 6, East, the outcrop has been traced by field parties and determined by authenticated drilling. The outcrop as mapped from the vicinity of New Denison northwestward to the line of the Chicago, Burlington and Quincy Railroad northwest of Marion represents determinations resulting from drilling. The data were supplied to the Survey but they have not been closely checked in the field. From the line of the Chicago, Burlington and Quincy Railroad westward to Carterville the position of the outcrop is only approximately accurate. The occurrence of the coal in this strip is considered in the description of special Area VI (p. 52). From Carterville west to the county line the margin of the coal has been discovered in places by drilling and open-cut mining, but has not been mapped in detail.

It will be noted in examining the maps that the outcrop of No. 5 coal in general closely parallels the outcrop of No. 6 coal, but that the parallelism is somewhat less close in Saline and eastern Williamson County than elsewhere. The closeness of the two lines of outcrop is of course due to the fact that the coal beds are generally separated by only about 25 to 30 feet of strata. In the eastern part of Williamson County, however, the interval between the two beds increases considerably; it is about 75 feet in the vicinity of Craborchard village, about 100 feet at the Saline-Williamson county line, and 125 feet near Carrier Mills. Eastward from Carrier Mills it decreases somewhat. The increase in the interval between Craborchard and Carrier Mills explains the wider separation of the outcrops of the two coals.

CHARACTER OF STRATA BETWEEN NO. 5 AND NO. 6 COALS

From Randolph County eastward to Williamson County the strata between the two coals consist of from 25 to as much as 60 per cent of limestone. In northeastern Jackson County where the coals are about 35 feet apart, the presence of 10 feet of limestone seems to be usual. Near Carterville the interval between the coals is about 40 feet, and here also about 10 feet of the intervening rock is limestone. Near the outcrop of No. 6 coal north of Marion No. 5 lies about 45 feet below No. 6 with 10 feet of limestone between the two coal beds. In T. 9 S., R. 3 W., the interval between the beds is from 50 to 60 feet, with no more than ten feet of limestone present, and in places as much as 17 feet of sandstone. In Range 4 E., where the interval is from 80 to 100 feet or more, usually less than 5 feet of limestone is present, but sandstones as much as 55 feet thick were encountered in some of the drill holes. It is noteworthy that only in eastern Williamson County where the intervening section contains a notable amount of sandstone is the line of outcrop of No. 5 coal marked by topographic irregularities. The coal outcrops at the foot of an escarpment marking the position of the outcropping sandstone lying between the coals. Elsewhere the outcrop of No. 5 coal is less readily followed because there are no resistant beds above it and the surface usually slopes gently across the outcrop of beds lying for some distance below No. 6 coal. Because of the resistance to erosion offered by the sandstone above No. 5 coal in eastern Williamson County and the resulting steep slope adjacent to the outcrop of the coal the thickness of the overburden increase rapidly and conditions for stripping this coal are not particularly good, but slope mining can be carried on very close to the outcrop. In central Saline County the rocks between the coals are largely shale and here again gentle slopes prevail for some distance north of the outcrop of the coal so that large scale open-cut mining is possible.

In the Sparta region the beds intervening between the two coals were very largely limestone. It is noteworthy that these are not sufficiently resistant to weathering and erosion to affect the topographic expression of the surface. Apparently these rocks did not conspicuously protrude from the preglacial surface. Their presence under cover is, however, very definitely established by the numerous test holes that have penetrated both coals. It is very evident that the most favorable situations for the recovery of No. 5 coal by open-cut methods are where the rocks intervening between No. 5 and No. 6 coals consist largely of shale, as in central and western Williamson County and in Saline County. Elsewhere stripping operations in No. 5 coal will be forced to handle considerable thicknesses of resistant rock, either limestone or sandstone.

NO. 5 COAL

THICKNESS

In the Sparta and Willisville region in Randolph County No. 5 coal usually has a thickness of about 4 feet, but varies from 40 to more than 60 inches. In general it appears to be more variable in thickness than No. 6 coal. In northeastern Jackson County the few available records of holes penetrating it indicate that its thickness is between 4 and 5 feet. One record reports as much as 5 feet 2 inches. At the pit of the Huskey Coal Company in western Williamson County the coal has a thickness of 4 feet. In Range 2 East it varies from 4 to 5 feet in thickness. Thence eastward it is usually more than 4 feet thick, though not generally more than five feet except between Carrier Mills and Harrisburg, where in places it is locally 7 to 8 feet thick.

CHEMICAL CHARACTERISTICS

The chemical character of No. 5 coal in Randolph, Williamson, and Saline counties is indicated by the analyses of face samples collected in mines in those counties, and given on the following page.

It will be noted that the analyses in Table 2 apparently favor the coals sampled in Williamson County. It is commonly true, however, that analyses made prior to 1912, before standardized methods of analysis were established, show calorific values somewhat higher than those determined for the coal from the same mine in 1912 and since that year. Although the quality of the coal is best indicated by the "unit coal" value it is doubtful whether No. 5 coal in Williamson County is in general superior in quality to the coal from the same seam in Saline County because of the lower ash content of the Saline County coal. Additional analyses of No. 5 coal in Williamson County are needed to establish its character definitely. Comparison of the analyses in Tables 2 (p. 20) and 3 (p. 27) indicate the superiority of the lower seam over No. 6 coal. In Randolph County the lower coal appears to have an advantage over No. 6 coal of about 300 B. t. u. on the unit coal basis and in southern Williamson County of at least 100 B. t. u. but the latter advantage is not well established by the data used. There are no analyses of No. 6 coal that can be used for comparison with determinations for No. 5 coal in Saline County.

The most notable difference in the character of No. 5 coal across the southern part of the State is in the amount of non-coal substance, that is moisture, ash, and sulphur, present in the coal. The impurities decrease considerably from west to east so that whereas the combustible constituents make up 76 per cent of the coal in Randolph County, they compose 80 per cent in Williamson County, and 85 per cent or more in Saline County.

TABLE 2.—*Analyses of No. 5 coal in Randolph, Williamson, and Saline counties*

(Face samples only)

Analysis No.	Date	Form of Analysis	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Calorific Value (B. t. u.)
8835[a]		As rec'd	13.90	35.33	41.33	9.44	4.84	11015
		Dry		41.03	48.00	10.97	5.63	12793
		Unit coal[e]						14709
8836[a]		As rec'd	12.21	35.22	41.61	10.96	4.47	11037
		Dry		40.12	47.40	12.48	5.10	12572
		Unit coal[e]						14711
1809[b]	9/08	As rec'd	6.47	35.96	45.84	11.73	3.39	12022
		Dry		38.45	49.02	12.53	3.62	12840
		Unit coal[e]						14985
896[c]	8/07	As rec'd	6.29	36.72	46.99	10.00	3.61	12251
		Dry		39.20	50.12	10.68	3.86	13073
		Unit coal[e]						14917
12918[d]	7/21	As rec'd	5.75	35.01	52.65	6.59	2.05	12800
		Dry		37.15	55.86	6.99	2.18	13581
		Unit coal[e]						14927
12919[d]	7/21	As rec'd	6.58	32.89	53.29	7.24	2.06	12565
		Dry		35.21	57.14	7.75	2.20	13450
		Unit coal[e]						14754
12917[d]	7/21	As rec'd	5.62	34.61	52.52	7.25	2.02	12781
		Dry		36.67	55.65	7.68	2.14	13542
		Unit coal[e]						14840

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[a] Near Blair, Randolph County. Analysis made since 1912.

[b] Local mine near Carterville, Williamson County.

[c] Spillertown Coal and Coke Co., Williamson County. Mine abandoned.

[d] Near Carrier Mills, Saline County.

[e] Ash, sulphur, and moisture free calorific value.

It is interesting to note that practically the same differences exist in the character of No. 6 coal, at least in Randolph and Williamson counties. It will be observed that the moisture content of No. 5 coal in Randolph County is notably higher than it is in the counties to the east.

PHYSICAL CHARACTERISTICS

The physical characteristics of No. 5 coal can be most satisfactorily described by means of detailed sections and the citation of observations made at the coal face in various places from Randolph County eastward.

Sections of No. 5 coal in mine No. 9, Willis Coal and Mining Co., Percy, sec. 11, T. 6 S., R. 5 W., Randolph County [a]

Section 1—Face of the 4th north entry

Strata	Thickness	
	Inches	*Inches*
Coal	2	
Charcoal	¼	
Coal	4½	
Charcoal	¼	
Coal	1½	
"Sulphur"		½
Coal	5	
Charcoal	¼	
Coal	5½	
"Sulphur"		¼
Coal	4½	
"Sulphur"		½
Coal	16	
"Sulphur"		⅛
Coal	5	
Clay mixture		¼
Coal	4½	
Total coal	49¼	
Total impurities		1⅝

Thickness of bed 50⅞ inches

Measured thickness 49 inches

Section 2—Face of main east entry

Strata	Thickness	
	Inches	*Inches*
Coal	8	
Charcoal	¼	
Coal	5	
Charcoal	¼	
Coal	1½	
"Sulphur"		½
Coal	7	
Charcoal	⅛	
Coal	3	
"Sulphur"		⅛
Coal	1	
"Sulphur"		⅛
Coal	11	
"Sulphur"		¼
Coal	13	
Clay		⅛
Coal	6	
Total coal	56⅛	
Total impurities		1⅛

Thickness of bed 57¼ inches

Measured thickness 57 inches

Section 3—Face of the 4th south entry

Strata	Thickness *Inches*	 *Inches*
Coal	4½	
Charcoal	¼	
Coal	6½	
Charcoal	¼	
Coal	9½	
"Sulphur"		½
Coal	4	
Charcoal	¼	
Coal with lenses of "sulphur"	17	
"Sulphur"		½
Coal	6	
Clay and charcoal		¼
Coal	8	
Total coal	56¼	
Total impurities		1¼
Thickness of bed		57½ inches
Measured thickness		57 inches

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[a]Observations by Wilson and Netzeband, 1912.

Observations by G. H. Cady in 1918: The coal does not lie in benches, but is uniform throughout. There are no "horsebacks" and no boulders in the roof. The coal contains a few scattered lenses of massive pyrite one inch thick and 4 to 6 inches across and an occasional lens of laminated pyrite, all in one general part of the mine.

Record of observations by H. E. Culver in 1925 in the local mine operated by Jones and Sons near Blair, sec. 26, T. 5 S., R. 6 W., Randolph County

The coal has a thickness varying from 51 to 60 inches and averaging 56 inches. It contains scattered lenses of brown and of bright pyrite but apparently at no persistent positions. The seam is not separated into distinct benches. The coal is described as consisting largely of dull bands. Facings of calcite, pyrite, and possibly gypsum occur as joint fillings in the coal.

Record of observations by H. E. Culver in 1925 in the strip mine operated by the Quaker Coal Co., now Huskey Coal Co., near Carterville, sec. 5, T. 9 S., R. 1 E., Williamson County

The coal has a thickness varying from 36 to 48 inches and averaging 42 inches. The coal lies in one bench, except that a layer of pyrite occurs rather persistently about 12 inches from the bottom of the coal. The coal contains rather numerous partings and lenses of charcoal.

Sections of No. 5 coal in mine No. 2 Wasson Coal Co., Carrier Mills, sec. 33, T. 9 S., R. 5 E., Saline County [a]

Section 1—Face of 11th east off the main north entry

Strata	Thickness *Inches*	 *Inches*
Shale		
Coal	12	
Charcoal	¼	
Coal	7¼	
Charcoal	¼	
Coal	31	
Pyrite lens		⅛
Coal	5½	
Total coal	56¼	
Total impurities		⅛
Thickness of bed		56⅜ inches
Measured thickness		57 inches

Section 2—Face of 5th east off main north entry

Strata	Thickness	
	Inches	*Inches*
Shale		
Coal	10¼	
Charcoal	¼	
Coal	43½	
Total coal	54	

Section 3—Room 24 off the 11th north off the main west entry

Strata	Thickness	
	Inches	*Inches*
Shale		
Coal	7	
Pyrite		¼
Coal	47½	
Total coal	54½	
Total impurities		¼
Thickness of bed		54¾ inches
Measured thickness		54½ inches

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[a] Measured by Netzeband, 1912.

The foregoing sections and other observations although less complete than is desirable, particularly with respect to the coal in Williamson County, indicate two noteworthy characteristics of the coal: (1) No. 5 coal differs from No. 6 coal in that it is a single bench seam. (2) The ash content decreases eastward across the State, but, so far as is known, it nowhere decreases to the extent to which the ash content of No. 6 coal decreases in parts of Williamson County. There is, however, very little reliable information about the character of No. 5 coal in Williamson County, so that generalizations are not of great value.

CHARACTER OF THE STRATA ABOVE NO. 6 COAL

Certain generalizations in regard to the character of the rocks associated with No. 6 coal will doubtless be of interest. Particular interest is attached to the character of the cap rock which is one of the most widespread beds in the Pennsylvanian formations of Illinois. Its presence within a short distance above the top of No. 6 coal is almost universal. It is invariably present west of Williamson County and in eastern Williamson and Saline counties. In central Williamson County its absence in places is one reason for the favorable stripping conditions for No. 6 coal in the region where are located the Pyramid, Mammoth, and Prosperity pits, near the line of the Chicago, Burlington, and Quincy Railroad between Herrin and Marion (Pl. VII). In a small area apparently not more than one mile wide the limestone cap seems to be generally absent. The area seemingly lies at the margin of a region extending northward into central Franklin County and widening to the east and west in which the limestone cap rock is generally absent or 25 feet or more above the coal.

It is approximately coterminous with the area in which No. 6 coal is 8 feet or more thick.

Where the cap rock is present its thickness increases somewhat from east to west. It is not commonly more than 8 feet in Saline and eastern Williamson County. Of 180 records of drill holes in Saline County most of which penetrated No. 6 coal only three report cap rock 10 feet or more in thickness. The greatest thickness reported is 12 feet, and the usual thickness is 6 feet or less. The limestone thickens somewhat through western Williamson County. In the strip pit operated by the Black Servant Coal Company, in northeastern Jackson County, the cap rock is about 7 feet thick. Between Duquoin and Pinckneyville where there has been much exploration, thicknesses in excess of 10 feet are common and in places the limestone is said to be as much as 20 feet thick. In western Perry County in the vicinity of Willisville the cap rock appears to have a very uniform thickness of about 6 feet; in the Sparta region it seems to be slightly thinner. In the Sparta-Willisville region two other persistent beds of limestone are present within 40 feet of the coal, one about 5 to 6 feet thick lying about 25 feet above the coal, and the other about 3 feet thick lying about 40 feet above the coal. These three limestones can be very definitely identified from drill hole to drill hole over a considerable area. Exploration with the drill east of Freeburg in St. Clair County indicates that the limestones present in Randolph County also underlie at least parts of St. Clair County and possess similar characteristics. The data herein presented indicate that the thickness of the cap rock as a single ledge is greatest in the Duquoin-Pinckneyville region.

Where open-cut mining requires the removal of a considerable thickness of limestone, as is the case generally along the outcrop of No. 6 coal, the value of the rock so removed is a matter of interest. The use to which the rock can be put depends very largely upon its chemical character. The Survey has in its files the single analysis of the cap rock given below which represents a sample collected in the Duquoin region.

Analysis of the limestone cap rock of No. 6 Coal near Duquoin, Illinois[a]

	Per cent
SiO_2	34.04
Fe and Al oxides	7.88
$CaCO_3$	50.86
CaO	28.56
$MgCO_3$	4.26
MgO	2.04
Loss of ignition	23.87
Alkalies (by difference) Na_2O and K_2O	3.67

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[a] Laboratory No. 15354. Analyst, J. M. Lindgren.

This analysis accords with the determinations of the physical character of the rock. In its usual manifestation it is an impure earthy limestone, from buff to dark gray in color. It is very sparingly fossiliferous. Where exposed it weathers to a smooth, light gray to buff surface. It is brittle and relatively soft and when struck sharply with a hammer breaks off in thin, more or less rectangular fragments parallel to the weathered surface and not to the bedding, which is not very definitely marked. The chief impurity is fine siliceous silt, in accordance with the very high per cent of silica determined by analysis. The weathered product produced by the decay of the rock has not the usual plastic character of material derived from pure limestones because of its high siliceous content. Physical and chemical examination of the rock indicates that in general it does not possess the characteristics of a high-grade limestone suitable for the manufacture of the better grades of agricultural limestone, portland cement, etc. Its possibilities of usefulness reside mainly in its qualifications for use as rubble and ballast.

The physical characteristics of the higher limestones present in the Randolph County area are such as to indicate that these beds are more highly calcareous than the cap rock of No. 6 coal. The writer is not aware that any analyses of these limestones have been made, but from a knowledge of their physical character as displayed in outcrop he is confident that the possibilities of their usefulness are much greater than those of the cap rock.

The strata other than limestone lying within 50 feet of No. 6 coal consist almost entirely of shale except in parts of Saline County. In western Kentucky a wide-spread sandstone known as the Anvil Rock sandstone overlies the cap rock of Herrin (No. 6) (Kentucky No. 11) coal. This sandstone has been identified in the Eagle Valley region in southern Gallatin County, Illinois.[3] In places in Saline County sandstone occupies a position similar to that of the Anvil Rock sandstone in Gallatin County, Illinois, and in western Kentucky. The presence of such a sandstone in the section above No. 6 coal may largely explain the southward facing escarpment extending from Ledford to Harrisburg, though it is probable that sandstone in this locality overlies a limestone known as the Bankston Creek limestone, the position of which is between 30 and 40 feet above No. 6 coal. There are numerous drill holes in Saline County, however, the records of which show the presence of thick sandstone beds within a few feet of the coal. Such sandstones do not seem to be present commonly west of the Williamson-Saline county line.

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[3] Butts, Charles, Geology and mineral resources of the Equality-Shawneetown area: Illinois State Geol. Survey Bull. 57, Pl. I, 1925.

NO. 6 COAL

CHEMICAL CHARACTERISTICS

Numerous chemical analyses of face samples show that the quality of the coal substance as expressed by the unit coal B. t. u. value (moisture, ash, and sulphur free) improves progressively eastward and southward across the southern part of the State, at least as far as eastern Williamson County. Whether this improvement in quality persists across Saline County there is at present no means of knowing as analyses are not available. This change in the character of the coal is demonstrated by the analyses in Table 3 which are so arranged that they refer to the quality of the coal at points successively farther and farther east. The unit coal B. t. u. value represents the heating value of the coal substance free from all non-coal substance; that is, moisture, ash, and sulphur. The "as received" B. t. u. value may be regarded as the unit coal B. t. u. value decreased in proportion to the amount of moisture, ash and sulphur in the coal as mined. It will be noted from an inspection of the data in Table 3 that of the three non-coal components, moisture shows the most definite change in quantity between the west and east sides of the State. The decrease in moisture together with an increase in the heating quality of the pure coal necessarily means that the coal as mined improves toward the southeast even though the ash and sulphur remain the same. It will be noted that the ash content in eastern Williamson County is not greatly different from that in St. Clair and Randolph counties. The sulphur content is only a little if any less. There is, however, an area in central Williamson County characterized by relatively low ash and sulphur content. The amount of moisture is intermediate. This low ash and sulphur content together with a relatively low moisture content provides as low a total non-combustible content as is found in the eastern part of the county where the moisture possesses its minimum value, but the ash and sulphur are slightly higher in amount. Therefore we find that the "as received" values of the coal in the central and eastern parts of Williamson County differ very little. Although the total non-coal substance in the coal in the two parts of the county is approximately the same, it is important to understand that a larger portion of the non-combustible material is ash in the coal mined in the eastern part of the county than is the case with respect to the coal in the central part of the county.

The chemical character of No. 6 coal in mines adjacent to its outcrop across the southern part of the State is shown by the analyses in Table 3.

TABLE 3.—*Analyses of No. 6 coal in mines adjacent to the outcrop of the coal in southern Illinois*

(Face samples only)

Analysis No.	Date	Form of Analysis	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Calorific Value (B. t. u.)
				St. Clair County				
12559[a]	5/21	As rec'd	11.5	37.2	41.7	9.6	2.8	11155
		Dry		42.0	47.1	10.9	3.2	12607
		Unit coal						14394
1600[b]	6/08	As rec'd	11.4	37.8	37.4	13.4	5.0	10547
		Dry		42.6	42.2	15.1	5.7	11908
		Unit coal						14435
2628[c]	7/09	As rec'd	10.0	37.6	41.0	11.3	4.4	11219
		Dry		41.8	45.6	12.6	4.8	12471
		Unit coal						14600
5524-6[d] Average	8/12	As rec'd	10.0	39.3	39.1	11.5	3.9	11045
		Dry		43.7	43.4	12.8	4.3	12278
		Unit coal						14398
12558[d]	5/21	As rec'd	9.4	37.2	40.9	12.6	4.0	10959
		Dry		41.0	45.1	13.9	4.4	12091
		Unit coal						14378

[a] Near Millstadt. [c] Near Lenzburg.
[b] Near Freeburg. [d] Near Marissa.

				Randolph County				
12564[a]	5/21	As rec'd	9.7	37.3	41.7	11.3	4.1	11135
		Dry		41.3	46.2	12.5	4.6	12330
		Unit coal						14412
5045-7[b] Average	8/12	As rec'd	11.1	37.3	40.1	11.4	4.2	10855
		Dry		43.7	43.4	12.8	4.3	12278
		Unit coal						14351

[a] Northern part of county.
[b] Central part of county.

				Perry County				
5034, 37, 38, 40, 42, 43[a] Average	6/12	As rec'd	10.95	37.0	41.8	10.2	3.6	11060
		Dry		41.5	47.0	11.5	4.0	12420
		Unit coal						14314
5514 19, 20[b] Average	8/12	As rec'd	12.45	36.1	42.8	8.6	2.8	11207
		Dry		41.3	48.8	9.9	3.2	12801
		Unit coal						14431
31033-6[c] Composite	10/18	As rec'd	12.04	33.9	44.8	9.2	1.5	11227
		Dry		38.5	51.0	10.5	1.7	12764
		Unit coal						14449

[a] Near Pinckneyville. [b] West of Duquoin.
[c] South of Duquoin; Security No. 1 mine; U. S. Bur. Mines Bull. 193, p. 33, 1922.

				Williamson County				
12875[a]	7/21	As rec'd	8.1	31.2	53.0	7.7	1.1	12156
		Dry		34.0	57.7	8.3	1.2	13164
		Unit coal						14508
4996, 5000, 5006[b] Average	6/12	As rec'd	8.2	33.9	48.9	9.0	2.2	11913
		Dry		37.0	53.2	9.8	2.3	13030
		Unit coal						14652
12883[c]	7/21	As rec'd	5.7	35.4	45.0	13.9	4.2	11514
		Dry		37.5	47.7	14.8	4.4	12215
		Unit coal						14695
12882[c]	7/21	As rec'd	4.9	37.0	46.7	11.4	3.4	12106
		Dry		38.9	49.1	11.9	3.6	12557
		Unit coal						14750

[a] Near Carterville.
[b] North of Marion.
[c] Northeast of Marion.

PHYSICAL CHARACTERISTICS

In the selection of a coal bed for open-cut mining its physical characteristics need to be taken into consideration as fully as the chemical characteristics, particularly when the analyses represent face samples of coal. Face sampling permits the discard of impurities greater than ¼-inch in thickness; hence it is quite possible that in some regions the importance of certain persistent banded impurities, which can scarcely be discarded in open-cut mining, is not fully realized.

The physical features of No. 6 coal differ considerably from point to point in the southern part of the State. The most conspicuous difference is between the coal east and that west of the Duquoin anticline, or approximately that position. There is no definite line of demarcation and it is probable that the Williamson County type of coal persists somewhat to the west of the line of the anticline into Jackson and Perry counties.

One of the very prominent and characteristic features of No. 6 coal is its "bench" arrangement. All through southern Illinois a division into a top, middle, and lower bench is possible. The lower bench is separated from the middle bench by a bed of shale, or fire clay, known as the "blue band" which is without question the most characteristic physical feature of the bed. The upper and middle benches are commonly separated by a "mother coal" or mineral charcoal parting which is probably significant of a time during which there was wide-spread oxidation of the surface of the peat deposit now represented by the coal. The coal above the parting; that is, the top coal, and the bottom coal below the blue band generally make solid benches of good coal, although the upper bench is probably superior in quality to the rest of the coal in the seam. It is in the physical character of the middle bench that there resides the great difference between the coal underlying the eastern and that underlying the western part of the southern end of the State. In some places in Williamson County and the Duquoin region the middle bench is solid like the top and bottom benches. Where it is split up, the thinner benches are not persistent and the partings are generally thin layers of mother coal. The lack of persistence of the subdivisions is noteworthy.

There follows a series of measured sections of No. 6 coal collected during the past twenty years by members of the Survey staff from mines adjacent to the outcrop through St. Clair, Randolph, Perry, and Williamson counties.

ST. CLAIR COUNTY

Section of No. 6 coal in mine of Pittsburg Mining Co., Belleville, sec. 16, T. 1 N., R. 8 W.[a]

About 1200 feet southeast of shaft

Strata	Thickness	
	Inches	*Inches*
Coal, top	11½	
Coal	15½	
Slate, blue		¾
Coal "drift"	11½	
Slate, blue		¾
Coal "block"	11½	
"Sulphur"		½
Coal	3	
Slate, blue		1
Coal	1¾	
Slate, blue (blue band?)		¾
Coal, bottom	18	
Total coal	72¾	
Total impurities		3¾
Thickness of bed		76½ inches

[a] Measured by W. F. Wheeler, 1907.

Section of No. 6 coal in strip pit operated by Chas. Deffenbaugh, Millstadt ,sec. 24, T. 1 S., R. 9 W.[a]

Strata	Thickness	
	Inches	*Inches*
Shale, carbonaceous, weathered		
Coal	8¾	
Shale		¼
Coal	12	
Pyrite		¼-½
Coal	14½	
Shale, pyritic		½-1
Coal	1¼	
Pyrite		¾
Coal	21	
Total coal	57½	
Total impurities		2½
Thickness of bed		60 inches
Measured thickness		59½ inches

[a] Measured by Wilson, 1921.

Section of No. 6 coal in mine of Mulberry Hill Coal Co., Freeburg, sec. 18, T. 1 S., R. 7 W.[a]

Strata	Thickness	
	Inches	*Inches*
"Slate," black		
Coal, hard, sulphur stringers, calcite facings	11¼	
Charcoal	¼	
Coal, mostly dull, with bony and "sulphur" lenses	10½	
"Sulphur" parting		¼
Coal, as above	5¾	
Shale		¼
Coal	15	
Shale, black		¾
Coal	12	
"Sulphur" lens		⅜
Coal	4	

"Sulphur" lens		1
Coal	4	
Shale		½
Coal	23½	
Total coal	86¼	
Total impurities		3⅛
Thickness of bed		89⅜ inches
Measured thickness		89 inches

*a*Measured by P. T. Post, 1925. Position in mine not stated.

Sections of No. 6 coal in mine of the Star Coal Co., Freeburg, sec. 30 T. 1 S., R. 7 W.[a]

Section 1—Sixth room off the 8th south on west side

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal, with "sulphur" lens (1 by 6 inches)	17¾	
Clay streak		
Coal	16	
Clay, "sulphur" in places		½
Coal	12	
Clay and "sulphur"		¼
Coal	4	
Blue band and pyrite		1
Coal	28½	
Total coal	28¼	
Total impurities		1¾
Thickness of bed		80 inches
Measured thickness		79 inches

Section 2—Measured near shaft on east side

Strata	Thickness	
"Slate," black	*Inches*	*Inches*
Coal	25½	
Clay, sulphur, mother coal parting		
Coal	13½	
Clay		½
Coal	9	
Clay, mother coal, "sulphur"		½
Coal	7	
Blue band		½
Coal	24½	
Total coal	79½	
Total impurities		1½
Thickness of bed		81 inches
Measured thickness		81 inches

Note: The partings Nos. 2, 4, 6, and 8, are very persistent throughout the mine. In many places one or more of them will be pyrite. The blue band is not uncommonly all pyrite.

Section 3—Fifth and sixth south entries on east side

Strata	Thickness	
"Slate," black	*Inches*	*Inches*
Coal	31	
Clay streak		
Coal	19	
Clay and pyrite		½
Coal	14	

Clay streak		
Coal	4	
Blue band		1
Coal	30½	
Mother coal	½	
Coal	21	
Total coal	120	
Total impurities		1½
Thickness of bed		121½ inches
Measured thickness		121½ inches

Note: Coal in this mine varies in thickness from 78 to 124 inches. The average thickness is 84 inches.

[a]Measured by G. H. Cady, 1918.

Section of No. 6 coal in Fairbanks (No. 3) mine, Kolb Coal Co., New Athens, sec. 2, T. 3 S., R. 7 W.[a]

Strata — Room 3 off third east entry	Thickness	
	Inches	*Inches*
Clod		
Shale (2 inches)		
Coal	12⅛	
"Sulphur"		⅛
Coal	10⅞	
"Sulphur"		¼
Coal	5	
"Sulphur"		⅛
Coal	9½	
Coal, bony		½
Coal	11½	
"Sulphur"		½
Coal	4⅛	
Blue band		⅝
Coal	22	
Clay		
Total coal	75⅛	
Total impurities		2⅛
Thickness of bed		77¼ inches
Measured thickness		77⅞ inches

[a]Measured by E. W. Shaw, 1911.

Section of No. 6 coal in mine No. 2, Borders Coal Co., Marissa, sec. 21, T. 3 S., R. 6 W.[a]

Strata	Thickness	
	Inches	*Inches*
Limestone more than 2 feet thick		
Coal, "blacksmith"	18	
Parting		⅛
Coal	24	
"Sulphur" and shale		¼
Coal	13½	
"Sulphur"		⅛
Coal	4½	
Blue band and "sulphur"		1½
Coal	18	
Clay		
Total coal	78	
Total impurities		2
Thickness of bed		90 inches

[a]Measured by Jon Udden, 1908. Location of section in mine not stated.

Sections of No. 6 coal in mine No. 1, Borders Coal Co., Marissa, sec. 27, T. 3 S., R. 6 W.[a]

Section 1—East room off south entry

Strata	Thickness	
	Inches	*Inches*
Limestone		
Coal, clean, bright	16½	
Pyrite		¼
Coal, dirty	15½	
Pyrite		⅜
Coal, very dirty	20½	
Pyrite		⅜
Coal, bony		4
Blue band, bone, shale, pyrite		1½
Coal, fairly clean, hard	19	
Clay		
Total coal	71½	
Total impurities		6½
Thickness of bed		78 inches
Measured thickness		78 inches

Section 2—Room 8 north off 6th east off north

Strata	Thickness	
	Inches	*Inches*
Shale, black		
Pyrite and bone		2
Coal, clean, bright	15¼	
Pyrite		¼
Coal, fairly clean	10	
Pyrite		¼
Coal, fairly clean and bright	16	
Bone and pyrite		¼
Coal, fairly clean	16	
Blue band; bone and shale		1½
Coal, dirty	23	
Clay		
Total coal	80¼	
Total impurities		4¼
Thickness of bed		84½ inches
Measured thickness		85 inches

Section 3—Room 5 from face of 2nd east off north

Strata	Thickness	
	Inches	*Inches*
Limestone		
Coal, top bench, clean, bright	9½	
Coal, clean, bright	15¼	
Bone		¼
Coal, dirty	16	
Pyrite and bone		¾
Coal, dirty	17	
Blue band; bone and shale		¾
Coal, dirty	18½	
Clay		
Total coal	76¼	
Total impurities		1¾
Thickness of bed		78 inches
Measured thickness		78 inches

[a] Measured by Nebel and Smith, 1912.

Sections of No. 6 coal in Meek mine of the Egyptian Coal and Mining Co., Marissa, sec. 36, T. 3 S., R. 6 W.[a]

Section 1—Fourth west entry south

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal	8	
Charcoal	¼	
Coal	5	
Pyrite		½
Coal	5	
Charcoal and pyrite		1
Coal	6¾	
Charcoal	¼	
Coal	15	
Charcoal	¼	
Coal	5	
Pyrite and charcoal		1
Coal	13	
Pyrite		½
Coal	4½	
Slate; blue band		¾–1
Coal	16	
Clay		
Total coal	79	
Total impurities		3¾
Thickness of bed		82¾ inches
Measured thickness		82 inches

Section 2—Main south entry

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal	12	
Pyrite		½–¾
Coal	14	
Clay mixture		½
Coal	9	
Pyrite		⅛
Coal	6½	
Shale and pyrite		½
Coal	16¼	
Shale, blue band		¾
Coal	16	
Clay		
Total coal	73¾	
Total impurities		2⅝
Thickness of bed		76⅜ inches
Measured thickness		76 inches

[a] Measured by J. M. Wilson, 1921.

RANDOLPH COUNTY

Section of No. 6 coal in the mine of the Boyd Coal Co., Sparta, sec. 1, T. 5 S., R. 6 W.[a]

Strata	Thickness	
	Inches	*Inches*
Draw "slate"		
Coal, top	14	
"Sulphur"		¼
Coal ("nine-inch bench")	12	
Parting		
Coal ("drift bench")	11	
Dirt		1/16
Coal ("block bench")	16	
"Sulphur"		¼

Coal	4	
Blue band		1½
Coal	11	
Total coal	68	
Total impurities		2 1/16
Thickness of bed		70 1/16 inches

*a*Measured by G. H. Cady. Location in mine not stated. Observations in 1918(?)

Sections of No. 6 coal in the mine of Moffat Coal Co., Sparta, sec. 8, T. 5 S., R. 5 W.[a]

Section 1—Location in mine not stated

Strata	Thickness	
	Inches	*Inches*
Clod, shaly		
Coal	11¼	
Shale		⅛
Coal, clean	4¾	
Coal with pyrite	5¾	
Shale		⅝
Coal with thin pyrite partings	11½	
Shale band		⅜
Coal	15⅞	
Shale		½
Coal	8	
Blue band, shale		1
Coal	5¾	
Clay		
Total coal	62⅞	
Total impurities		2⅝
Thickness of bed		65½ inches

Section 2—North rib on 10th west (in 120 feet east of face) off 13th south. Called main 10th west

Strata	Thickness	
	Inches	*Inches*
Shale, black fissile		
Coal	7⅛	
Pyrite parting		2/8
Coal	5	
Pyrite parting		⅛
Coal	9 6/8	
Shale		2/8
Coal	5⅜	
Charcoal parting	⅛	
Coal	7	
Charcoal parting	2/8	
Coal	3⅛	
Shale		4/8
Coal	13⅝	
Shale and pyrite band		4/8
Coal	4⅛	
Blue band, shale		1 6/8
Coal	6 6/8	
Clay		
Total coal	62¼	
Total impurities		3⅜
Thickness of bed		65⅝ inches
Measured thickness		65 6/8 inches

Note: Culver reports that the shale partings are persistent; about as much so as the so-called blue band, which here is very low in most parts of the mine. In the abundance of relatively persistent partings this bed appears to be more like No. 6 coal in the Belleville region than like the coal in the vicinity of Duquoin.

*a*Measured by H. E. Culver, 1925(?).

Section of No. 6 coal in mine No. 4, Illinois Fuel Co., Sparta, sec. 16, T. 5 S., R. 5 W.[a]

Face of 13th east off main north entry

Strata	Thickness *Inches*	Thickness *Inches*
Shale, fissile		
Coal, top (estimated)	8	
Parting		
Coal	24 6/8	
Shale		4/8
Coal	13	
Charcoal and pyrite lens		⅜
Coal	3	
Pyrite		2/8
Coal	14	
Pyrite band		⅜
Coal	1 6/8	
Pyrite parting		⅛
Coal	1⅛	
Shale; blue band		1 4/8
Coal with thin pyrite lenses	12 6/8	
Clay		

Total coal 78⅜

Total impurities 3⅛

Thickness of bed .... 81½ inches

Measured thickness 72 inches plus estimated 8 inches .... 80 inches

[a] Measured by H. E. Culver, 1925 (?)

Sections of No. 6 coal in mine No. 6, Willis Coal and Mining Co., Percy, sec. 14, T. 6 S., R. 5 W.[a]

Section 1—Twenty-first south entry

Strata	Thickness *Inches*	Thickness *Inches*
"Slate"		
Coal	9	
"Sulphur"		¼
Coal	7	
"Sulphur"		¼
Coal	28½	
Clay		¼
Coal	10	
Shale		¼
Coal	13½	
Shale		1
Coal	2½	
Blue band		2
Coal	15	
Clay		

Total coal 85½

Total impurities 4

Thickness of bed .... 89½ inches

Measured thickness .... 87½ inches

Section 2—Face of main east

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal	14½	
"Sulphur"		¾
Coal	10	
"Sulphur"		¼
Coal	7	
Clay		1
Coal	10½	
"Sulphur"		½
Coal	6½	
"Sulphur"		½
Coal	9	
Blue band, shale and "sulphur"		1¼
Coal	7	
"Sulphur"		½
Coal	5	
Clay		
Total coal	69½	
Total impurities		4¾
Thickness of bed		74¼ inches
Measured thickness		75 inches

Section 3—Face of the 12th north entry

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal	5½	
"Sulphur"		¼
Coal	10	
"Sulphur"		¼
Coal	9	
Charcoal	⅛	
Coal	2	
Shale		¼
Coal	8	
Clay		¼
Coal	6	
Charcoal	¼	
Coal	3	
Shale		¼
Coal	1½	
"Sulphur"		¼
Coal	13½	
"Sulphur"		¼–½
Coal	3	
Blue band; shale		1½
Coal	16	
Total coal	77⅞	
Total impurities		3⅜
Thickness of bed		81¼ inches

[a] Measured by Wilson and Netzeband, 1921.

PERRY COUNTY

Sections of No. 6 coal in mine No. 8, Willis Coal and Mining Co., Willisville, sec. 30, T. 6 S., R. 4 W.[a]

(Depth to coal, 67 feet; average thickness, 72 inches)

Section 1—12th south off 1st east

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal, hard	3	
Coal, softer, pryrite and calcite strings	27	
Clay and charcoal		4½
Coal	8½	
Clay		¼
Coal	16	
Clay		½
Coal	4	
Clay, blue band		¾
Coal, hard	11	
Underclay		
Total coal	69½	
Total clay and impurities		6
Thickness of bed		75½ inches
Measured thickness		74 inches

Section 2—12th north off 1st east at entry

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal	6	
Coal, softer, pyrite, and calcite strings	27	
Clay and charcoal		3½
Coal	9½	
Clay		¼
Coal	14	
Shale and pyrite, blue band		½
Coal	4	
Shale and clay		½
Coal	13	
Total coal	73½	
Total clay and impurities		4¾
Thickness of bed		78¼ inches
Measured thickness		75 inches

Section 3—3rd south off main east

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal, hard top	5½	
Coal	21	
Shale		⅜
Coal	12	
Coal and charcoal	3	
Coal	23	
Shale, blue band		1½
Coal	11	
Total coal	75½	
Total clay and impurities		1⅞
Thickness of bed		77⅜ inches
Measured thickness		75½ inches

Section 4—4th west off 3rd south

Strata	Thickness *Inches*	*Inches*
"Slate"		
Coal, top	6½	
Coal	4	
Shale and pyrite		¼–⅜
Coal	10	
Shale		¼
Coal	33	
Shale, blue band		1½
Coal	9½	
Total coal	63	
Total clay and impurities		2⅛
Thickness of bed		65⅛ inches
Measured thickness		65 inches

[a] Notes by Wilson.

Sections of No. 6 coal in mine No. 1, Willis Coal and Mining Co., Willisville, sec. 30, T. 6 S., R. 4 W.

(Depth to bottom of coal 86 feet; average thickness 74 inches)

Section 1—Face of the 5th main south entry[a]

Strata	Thickness *Inches*	*Inches*
Black "slate" roof		
Coal, brittle, very hard, bright	14	
Coal, hard, bright, less brittle	10	
Coal, laminated, filled with "mother coal" in thick layers, bands and glance coal between	12	
Coal, about same, little more solid	12	
Coal, more solid, but with "mother coal"	12	
"Blue band"		?
Coal, dirty, considerable sulphur and "mother coal"	15	
Total thickness		75 inches

Section 2—1st Room off 7th south off main east 4000 feet southeast of shaft[b]

Strata	Thickness *Inches*	*Inches*
Draw "slate"		
Coal	13	
Mother coal	½	
Coal	11	
"Sulphur"		⅛–¼
Coal	6	
Mother coal	½	
Coal	29	
Blue band		1
Coal	13	
Underclay		
Total coal	73	
Total clay and impurities		1¼
Thickness of bed		74¼ inches

[a] Notes by K. D. White, 1912.

[b] Notes by Jon Udden before 1910.

Section of No. 6 coal in the mine of the Illinois Sixth Vein Coal Co., Pinckneyville, sec. 13, T. 5 S., R. 3 W.[a]

Strata	Thickness	
	Inches	*Inches*
"Slate"		
Coal	8	
Charcoal	¼	
Coal with stringers of "sulphur"	27	
Charcoal	½	
Coal	7	
"Sulphur"		¼
Coal with bedded "sulphur"	17	
"Sulphur"		¼
Coal	2½	
Blue band; shale and "sulphur"		1
Coal	3½	
Shale		¼
Coal	7	
Total coal	72¾	
Total impurities		1¾
Thickness of bed		74½ inches
Measured thickness		73 inches

[a] Measured by Wilson and Netzeband, 1921, at face of first west entry.

Sections of No. 6 coal in mine of the Ritchey Coal Co., Pinckneyville, sec. 23, T. 5 S., R. 3 W.

Section 1—At face of room 4 on 2nd west, north side[a]

Strata	Thickness	
Shale, carbonaceous	*Inches*	*Inches*
Coal (top coal), irregular parting below; brittle and hard; calcite and "sulphur" plates scattered through coal	8	
Coal with mother coal in thick bands; less calcite and "sulphur"	28	
Coal, with bands of bone and sulphur for 3 inches above blue band	30	
Blue band		1½
Coal, with shale bands and considerable bone and dirt	18	
Total coal	84	
Total impurities		1½
Thickness of bed		85½ inches

Section 2—At face of entry of 4th east off main north, 1000 feet from shaft[b]

Strata	Thickness	
	Inches	*Inches*
Coal, bright	40	
Mother coal	1	
Coal bright	1	
"Sulphur" streak		1
Coal, bright	2	
Mother coal	1	
Coal, bright	22	
Blue band		¾
Coal, bright	3	
Blue band		1
Coal, bright	2	
Mother coal	1	
Coal, bright	17	
Total coal	90	
Total impurities		2¾
Thickness of bed		92¾ inches
Measured thickness		92¾ inches

[a] Measured by K. D. White, 1912.
[b] Measured by McDonald and Stafford, 1912.

Section of No. 6 coal in strip pit operated by the Scott Smith Coal Co., Duquoin, secs. 16 and 17, T. 6 S., R. 1 W.[a]

Strata	Thickness Inches	 Inches
Coal, few inches gone, rather hard, dull, with "sulphur" facings	3	
Charcoal	¼	
Coal, more bright	8	
Charcoal	⅛	
Coal, more dull bands	7¼	
Clay "sulphur" parting		¼
Coal, alternating 2-inch bands of dull and bright coal	31¼	
Shale, dark gray, blue band		1¼
Coal, exposed	3	
Coal, unexposed	?	

[a] Measured by P. T. Post in SW. ¼ SW. ¼ sec. 16, 1925.

Sections of No. 6 coal in mine of Security Coal and Mining Co., Duquoin, sec. 29, T. 6 S., R. 1 W.[a]

Section 1—In room 2 off the 17th north off 4th west north, 1000 feet north, 5000 feet west of shaft

Strata	Thickness Inches	 Inches
Roof: shale, gray, clay		
Coal, top, left for roof	12	
Coal, interbedded bright and dull layers, "sulphur" spangles and vertical seams of pyrite	60	
Mother coal	½	
Coal, hard, brilliant	1¾	
Blue band		2
Coal	12	
Floor: gray underclay		
Total coal	86¼	
Total impurities		2
Thickness of bed		88¼ inches
Measured thickness		88¼ inches

Section 2—In room 8, south off 6th east south 2500 feet south and 2000 feet east of the shaft

Strata	Thickness Inches	 Inches
Roof: shale, gray, clay		
Coal, top, not mined	24	
Coal with bright luster	12	
Mother coal and clay		¼
Coal, banded dull and bright	7	
Mother coal	¼	
Coal, bright with dull bands	32½	
Blue band		1¾
Coal	14½	
Total coal	90¼	
Total impurities		2
Thickness of bed		92¼ inches
Measured thickness		92 inches

[a] Measured by Schroyer, 1918.

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Sections of No. 6 coal in John mine, Carterville and Big Muddy Coal Co., Carterville, sec. 33, T. 8 S., R. 1 E.[a]

Section 1—Room 10 in the main north 60 feet from face

Strata	Thickness *Inches*	*Inches*
Shale		
Coal, roof	20 (approx.)	
Coal with stringers of pyrite and calcite	15	
Mineral charcoal	¼	
Coal	38	
Pyrite		⅛
Coal	10	
Blue band, shale		1½
Coal	12	
Pyrite		¼
Coal	10	
Total coal	105¼	
Total impurities		1⅞
Thickness of bed		107⅛ inches
Measured thickness (exclusive of top coal)		85½ inches

Section 2—Cross cut 25 feet from face of 10th north off 14th west

Strata	Thickness *Inches*	*Inches*
Shale		
Coal, roof, estimated	24	
Coal, stringers and lenses of pyrite	30	
Charcoal	⅛	
Coal	40	
Blue band, shale, and coal		2
Coal	21	
Total coal	115⅛	
Total impurities		2
Thickness of bed		117⅛ inches
Measured thickness (exclusive of top coal)		94 inches

[a] Measured by J. M. Wilson, 1921.

Sections of No. 6 coal in mine No. 8, Madison Coal Co., Dewmaine, sec. 35, T. 8 S., R. 1 E.[a]

Section 1—Face of 7th south off main west

Strata	Thickness *Inches*	*Inches*
Shale		
Coal left as roof	18 (approx.)	
Charcoal parting		
Coal	18	
Charcoal	¼	
Coal	12¾	
Charcoal	1	
Coal	13½	
Charcoal	½	
Coal	16¼	
Blue band, shale		¾
Coal	24	
Total coal	104¼	
Total impurities		¾
Thickness of bed		105 inches
Measured thickness (exclusive of top coal)		89½ inches

Section 2—Face of 3rd south off 3rd west

Strata	Thickness Inches	Inches
Shale		
Coal left as roof	18 (approx.)	
Charcoal parting		
Coal	24½	
Charcoal	⅛	
Coal with pyrite stringers	14	
Coal with charcoal partings	4	
Coal	8½	
Blue band; shale with coal stringers		2
Coal	10	
Charcoal	⅝	
Coal	11½	
Charcoal (blackjack) lens		1¾
Coal	1½	
Total coal	92¾	
Total impurities		3¾
Thickness of bed	96½ inches	
Measured thickness (exclusive of top coal)	79 inches	

[a]Measured by Netzeband, 1921.

Sections of No. 6 coal in mine No. 1, Taylor Coal Co., Herrin, sec. 32, T. 8 S., R. 2 E.[a]

Section 1—Third northwest room 56

Strata	Thickness Inches	Inches
Shale		
Coal left as roof	14 (approx.)	
Coal with pyrite lenses and stringers	42½	
Charcoal	½	
Coal	16½	
Blue band		1
Coal	5	
Shale		¾
Coal	8	
Clay mixture		1
Coal	13	
Total coal	99½	
Total impurities		2¾
Thickness of bed	102¼ inches	
Measured thickness (exclusive of top coal)	87 inches	

Section 2—Third southwest room 50

Strata	Thickness Inches	Inches
Shale, white		
Coal left as roof	14 (approx.)	
Coal	22½	
Charcoal	1¼	
Coal	3	
Charcoal	2	
Coal	10½	
Shale		¼
Coal	3	
Shale and pyrite		½

Coal with pyrite stringers	14½	
Blue band; shale and pyrite		1¼
Coal	12½	
Pyrite		1¼
Coal	7½	
Total coal	90¾	
Total impurities		3¼
Thickness of bed		94 inches
Measured thickness (exclusive of top coal)		81 inches

[a]Measured by Netzeband, 1921.

Sections of No. 6 coal in mine No. 2, Sincerity Coal Co., Marion, sec. 34, T. 8 S., R. 2 E.[a]

Section 1—Face of the 5th east off the back north

Strata	Thickness	
	Inches	*Inches*
Coal left as roof	18 (approx.)	
Coal, stringers of pyrite	9	
Charcoal	⅜	
Coal	14 6/8	
Charcoal	⅛	
Coal	20 4/8	
Shale		4/8
Coal	15 4/8	
Blue band; shale mixed with coal		1
Coal	22	
Clay		
Total coal	100¼	
Total impurities		1½
Thickness of bed		101¾ inches
Measured thickness (exclusive of top coal)		83½ inches

Section 2—Face of the main north entry

Strata	Thickness	
	Inches	*Inches*
Coal left as roof	18 (approx.)	
Coal; joints filled with pyrite	12	
Charcoal	1	
Coal	14	
Charcoal	⅛	
Coal	35 4/8	
Blue band; shale and coal		2
Coal	20	
Clay		
Total coal	100⅝	
Total impurities		2
Thickness of bed		102⅝ inches
Measured thickness (exclusive of top coal)		84¼ inches

[a]Measured by Netzeband, 1921.

Sections of No. 6 coal in the mine of Orchard Coal Co., Pittsburg, sec. 2, T. 9 S., R. 3 E.[a]

Section 1—Room 19 off the 2nd north entry

Strata	Thickness	
	Inches	*Inches*
"Slate" black		
Coal with pyrite stringers	4½	
Pyrite lens		⅛
Coal	32½	
Pyrite lens		⅛
Coal	20	
Blue band; shale		1
Coal	11½	
Total coal	68½	
Total impurities		1¼
Thickness of bed		69¾ inches
Measured thickness		69 inches

Section 2—Face of 2nd south of main east

Strata	Thickness	
	Inches	*Inches*
"Slate" black		
Coal	1½	
Pyrite		⅛
Coal	21	
Charcoal	¼	
Coal	25	
Pyrite		¼
Coal	13	
Blue band; shale		½
Coal	6	
Pyrite		⅛
Coal	23	
Total coal	89¾	
Total impurities		1
Thickness of bed		90¾ inches

[a] Measured by J. M. Wilson.

PART III

SPECIAL AREAS IN SOUTHERN ILLINOIS IN WHICH EXPLORATION FOR COAL SUITABLE FOR OPEN-CUT MINING IS RECOMMENDED

INTRODUCTION

Six special areas crossed by the outcrop of No. 6 coal are recommended for investigation with the view of determining the availability within them of bodies of coal suitable for recovery by open-cut mining. The areas selected for consideration are not those in which the most information is available concerning the position of the margin of the coal bed or beds. In some areas along the outcrop of No. 6 coal and also of No. 5 coal exploration in anticipation of development has been thorough and the position of the coal bed explored can be indicated with considerable accuracy. General interest, however, is not directed toward these explored or developed areas but toward the remaining unexplored areas. Although the amount of available information about some of these areas is unfortunately small certainly its compilation, together with the presentation of general facts in regard to the coals and associated strata, will be of assistance in directing the course of further investigations and explorations.

The available information in regard to the areas selected for description is assembled on Plates II–VII. On each map is indicated the outcrop of No. 6 coal as closely as this can be determined from the data at hand. Since all outcrops, drill holes, mines, etc., are indicated by symbols, the absence of such symbols implies that the line of outcrop is simply the closest approximation to accuracy that general information permits. The nature of this general information consists mainly of determinations in regard to the altitude of the coal at mines and drill holes adjacent to the margin of the bed. From a comparison of such data can be determined the general slope of the coal-bearing rocks in the vicinity of the outcrop of the coals. The topographic maps available furnish information in regard to the surface altitude. With the depth of the coal at any point near the outcrop, the slope of the beds, and the altitude of the surface all known, obviously a close approximation to the position of the outcrop can be made, provided the thickness of the unconsolidated covering is not highly variable. The variation in the thickness of the glacial and alluvial material in fact provides the greatest element of uncertainty in maps of this kind, and is one of the reasons why drilling along the outcrop must be closely spaced in order to "prove" the coal thoroughly and convincingly. In view of the consideration expressed it is hoped that the reader will not regard the maps as delineating facts established by detailed exploration but rather as simply indicating probabilities and, to that extent, of possible service in directing exploration.

The areas will be considered serially from west to east.

AREA I

Special Area I (Pl. II) embraces a region in northern St. Clair County lying along the outcrop of No. 6 coal between Freeburg and the vicinity of Belleville and extending southward about six miles from the environs of Belleville. Most of the area lies in T. 1 S., R. 8 W. It includes part of each of two quadrangles, New Athens on the east, and Waterloo on the west. The larger part of the area lies in New Athens quadrangle.

The outcrop of No. 6 coal in the part of the area included in the New Athens quadrangle is approximately as mapped by Shaw.[1] The outcrop in the remaining portion of the area is extended from the end of the outcrop line in the New Athens quadrangle southward in a position determined with reference to a few outcrops, a small strip mine, scattered drilling, and the altitude of the surface. So far as is known there are no outcrops of the coal at the surface along the entire designated position of outcrop. The line is to be regarded therefore simply as an approximation to the actual conditions. The coal lies buried beneath an overburden consisting largely of alluvium to a depth of 20 feet or more.

The position of the margin of the coal bed is very largely determined by the altitude of the coal as it approaches the outcrop line. The altitude of the coal, where it is 400 feet or more above sea level, is shown by structure contours having an interval of 50 feet. The position of the 400-foot contour is determined by the altitude of the coal in numerous shafts along the Illinois Central Railroad and roughly parallels the line of the railroad. Drill holes and mines located northeast of the railroad indicate a general dip of the coal in that direction so that it is probable that the bed rises at about the same rate toward the southwest, and that its outcrop will have approximately the position indicated. Since the surface northeast of the position of the 400-foot structure contour line has everywhere an altitude exceeding 460 feet, it is apparent that the coal lies too deep for open-cut mining in that direction. So far as the writer is aware, there has been no drilling to explore the margin of the bed between Freeburg and Belleville. It is probable that examination of mine maps and elevations of those mines located close to the designated position of the outcrop would furnish definite information about the actual position of the outcrop and the depth of the coal in part of the area, and so far as possible such examination should be made if exploration of any part of the area is contemplated.

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[1] Shaw, E. W., U. S. Geol. Survey Geol. Atlas, New Athens-Okawville folio (No. 213), fig. 5, p. 7, 1921.

From the data available, tracts in Area I which appear to be particularly suitable for investigation are as follows: sec. 11 and the N. ½ sec. 14, T. 1 S., R. 8 W.; sec. 5 and the E. ½ sec. 6 of the same township. The line of designated outcrop west of Freeburg in secs. 24 and 25 indicates the coal as outcropping at an altitude between 400 and 450 feet. This signifies that the depth of surface covering here is possibly as much as 75 feet. It is altogether probable that it is actually much thinner than this and that therefore the margin of the coal may lie as much as a mile farther west than as indicated. A line of test holes 50 to 75 feet in depth, or sufficiently deep to penetrate the coal at approximately ¼-mile intervals from the center of sec. 19 to the center of sec. 23 would determine the margin of the coal. It is thought probable, likewise, that the boundary is mapped too far north in the S. ½. Sec. 33, T. 1 N., R. 8 W., since the surface cover here is likewise indicated as about 75 feet thick. The southward extent of the workings of the Perry Coal Company in the SW. ¼ sec. 34 would afford important information in regard to the bed in that direction. Sec. 4, T. 1 S., R. 8 W., therefore, offers possibilities of being underlain by bodies of shallow coal.

AREA II

Area II (Pl. III) lies along the outcrop of No. 6 coal from the St. Clair-Randolph county line northwest to the vicinity of New Athens. Within it is included part of each of four quadrangles. Most of the area, like Area I, lies in the New Athens quadrangle. It crosses a corner of Okawville quadrangle northeast of Marissa. South of New Athens and Okawville quadrangles are respectively the Baldwin and Coulterville quadrangles; the boundary passes through the north part of Marissa. The boundary between the Baldwin and Coulterville quadrangles lies east of the larger part of the town of Marissa.

Geological field investigations have been made in the area included in this map. A map of the geology of the New Athens-Okawville quadrangles has already been published[2] and the outcrop of No. 6 coal as shown by Shaw for the New Athens quadrangle corresponds closely with the outcrop as indicated on the map of Area II (Pl. III). The outcrop within the area of the Baldwin quadrangle west and southwest of Marissa is very much generalized and is based on the relationship existing between the altitude of the coal at Marissa, the dip of the rock strata, and the surface configuration. The position of the outcrop as indicated in the New Athens quadrangle seems to rest upon no better basis, since there are no exposures or drill holes to determine its position.

The map shows the position of the top of No. 6 coal by 25-foot contours from an altitude of 350 feet upwards. Since except immediately adjacent to the valley of Kaskaskia River the surface has an altitude of 420 feet or more where the coal is 350 feet or below no stripping operations can be conducted north of the position of the 350-foot contour. The position of the 350- and of the 375-foot contour lines is determined very largely by reference to the altitude of the coal in the rather closely spaced mines along the Illinois Central Railroad. Persons having access to the mine maps and level data in the mines can verify the map or rectify any errors to the extent that mine workings extend south of the railroad toward the designated outcrop.

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[2] Shaw, E. W., op. cit.

The areas that seem most favorably situated topographically for investigation lie between the areas of alluvium along Doza Creek and along Kaskaskia River at New Athens. The Dutch Hill region 2 miles west of Lenzburg, in secs. 2, 3, 10 and 11, sec. 13 directly south of Lenzburg, and sec. 33 south of Marissa, all in T. 3 S., R. 7 W., are thought to merit particular mention. The fact that No. 6 coal lies at a depth of only 55 feet in the abandoned mine in sec. 21, T. 3 S., R. 7 W., gives some importance to the area in secs. 20, 21 and 28 adjacent to this mine. This area does not, however, appear to be topographically well situated. It may be generally assumed that where the cover is less than 20 feet the coal will probably be unsuitable for recovery.

Coal No. 5 is not believed to be present in this area, but there is need for drilling to determine whether or not a coal is present within 50 feet of No. 6 coal. In the Sparta region the coal called No. 5 lies about 30 feet below No. 6.

AREA III

Area III is in T. 4 S., R. 6 W., and lies adjacent to and northwest of Sparta (Pl. IV). It forms part of the region included in the map of the Sparta area showing the structure of No. 6 coal published by the Survey in 1926.[3] Plate IV shows the structure of No. 6 coal approximately the same as that given by Moulton. It will be noted, however, that data in regard to the position of the coal are indefinite in the north half of the area.

The outcrop of No. 6 coal can be traced fairly accurately from the south boundary of the area to Plum Creek. The limestone reported outcropping or near the surface along Plum Creek in the NE. ¼ NE. ¼ sec. 27, T. 4 S., R. 6 W., is arbitrarily correlated with the cap rock of No. 6 coal. It may, however, be the limestone between No. 5 and No. 6 coals, and if so, the outcrop of No. 6 coal is drawn too far west in sec. 27. From Plum Creek northward to the county line no great amount of accuracy can be claimed for the outcrop line. If the altitude of the coal is approximately accurately mapped the line of outcrop as indicated cannot be greatly in error. It is probable that the line lies too far to the west rather than too far to the east. The particular value of the map north of Plum Creek lies in the fact that it indicates the approximate area in which prospecting for coal lying at shallow depth might well be conducted. This area is bounded on the east by the 400-foot structure contour. It can hardly be expected that strippable coal will be found east of this line except possibly in a small area on the north side of Plum Creek in the S. ½ secs. 22 and 23. The line showing the outcrop of the coal bounds the area on the west. The fact that in this district there are extensive nearly level surfaces possibly underlain by coal also lying nearly horizontal is particularly noteworthy. To the writer it appears that in view of the absence of rock outcrops in the region and of drill holes and deep farm wells exploration should be conducted by a series of test holes running west approximately from the position of the 400-foot structure contour line.

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[3] Moulton, Gail F., Oil and gas possibilities near Sparta: Illinois State Geol. Survey Press Bulletin Series, Illinois Petroleum No. 1, Pl. I, pp. 4-5, April 17, 1926.

In drilling along the margin of the coal bed as indicated care will need to be exercised in the identification of the coals encountered. The actual existence of lower coals north of Sparta is uncertain because the diamond drill test holes stop at No. 6 coal. The identity of the coal encountered at 90 feet in the shaft located near the center of sec. 34 is uncertain. The coal there mined is reported to be 6 feet thick and until more definite information in regard to it becomes available it is tentatively correlated as No. 5. A bed of poor coal is reported to have been encountered at a depth of 293 feet in a well at the creamery at Houston. The coal is said to have been 4 feet thick with a clay band in the middle. If such a coal is present at that depth at Houston, it has the approximate stratigraphic position of No. 2 coal. From the foregoing statements it will be seen that the information in regard to coal-bearing strata below No. 6 coal in this region is very indefinite.

Areas recommended for exploration in Area III are as follows: sec. 26, west of the 400-foot structure contour; from the road running through the center of sec. 14 westward to the center of sec. 16; W. ½ sec. 10 and north and east halves sec. 9; sec. 4 and SE. ¼ sec. 5.

AREA IV

Area IV lies in the south-central part of Perry County, largely in T. 6 S., R. 3 W. (Pl. V). Four quadrangles corner in the northwest part of the area: Coulterville on the northwest, Pinckneyville on the north, Murphysboro on the south and Campbell Hill on the southwest.

It will be noted by inspection of the map that No. 6 coal underlies a considerable portion of the north half of the area. Except on the west the position of the outcrop is largely in Pinckneyville quadrangle. This area has not yet been geologically mapped, but a geological map has been published of the Murphysboro quadrangle[4]. Detailed field investigations have been made in both the Coulterville and the Campbell Hill quadrangles but the results of these investigations have not yet been published.

There are no outcrops of coal so far as known at any point along the designated margin of the bed. The drift conceals this margin so that its position can be indicated with only approximate correctness in accordance with data regarding the position and depth of the coal or the cap rock farther north, the dip of the coal-bearing beds, and the topographic configuration of the surface. Three drill holes are situated south of the outcrop of No. 6 coal. Along Galum and Little Galum creeks are a number of outcrops of limestone reported by Worthen[5] and he also reports that limestone was encountered at shallow depth in numerous farm wells located between Galum Creek and Pyatts. This limestone is thought to be the cap rock of No. 6 coal. There is a shallow slope mine in sec. 16, T. 6 S., R. 3 W. The coal has also been mined in the SE. ¼ sec. 22, T. 6 S., R. 4 W., and the sink holes mapped on the Campbell Hill sheet along the north line NW. ¼ sec. 26 indicate the presence of an underlying limestone, probably the cap rock of the coal. The limestone outcrops along Galum Creek in the E. ½ sec. 18, T. 6 S., R. 3 W., and along Little Galum Creek in sec. 9 of the same township. A slope or shaft located in the NE. ¼ NW. ¼ sec. 35, T. 6 S., R. 4 W., is thought to have reached No. 5 coal in view of the probable altitude of No. 6 coal at this place if it were present.

The surface in the S. ½ secs. 26 and 27, T. 6 S., R. 4 W., is rather deeply underlain by glacial drift so that the outcrop line is only a rough approximation to accuracy. Even greater indefiniteness characterizes the available information in regard to the margin of the coal bed in the area near Denmark between Pipestone and Galum creeks. Eastward from Galum Creek the line is somewhat more definitely established because of the occurrence of limestone in the wells along the road west from Pyatts through secs. 13, 14, 15, and 16. Even here the coal may extend farther south than is indicated along the ridges between the streams. The strata are nearly horizontal and in many places may locally dip south, as they are known to do in a similar position on the east side of Beaucoup Creek where a large area has been prospected by the United Electric Coal Company.

It is thought that this area contains large blocks of No. 6 coal suitable for recovery by open-cut methods. It is believed that the most favorable region for investigation lies north of the indicated position of the outcrop and east of Little Galum Creek. The area between Pipestone and Galum creeks including secs. 13 and 14 and the N. ½ secs. 23 and 24, T. 6 S., R. 4 W., is also favorably situated. A smaller area recommended for investigation lies in the N. ½ sec. 17 and S. ½ sec. 8, T. 6 S., R. 3 W., between Galum and Little Galum creeks.

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[4] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), 1912.

[5] Worthen, A. H., Geological Survey of Illinois, vol. III, p. 91, 1868.

The greatest difficulty in open-cut mining in this area will be the removal of the cap rock. In Perry and Randolph counties this stratum appears to be thicker than it commonly is elsewhere, and it is probable that the average thickness is at least 8 feet.

Drilling along the margin of No. 6 coal should be continued at least here and there to a depth no less than 50 feet below No. 6 coal or until No. 5 coal is encountered. The character of the surface south of the designated margin of No. 6 coal, particularly in secs. 22, 23, 26, and 27, T. 6 S., R. 3 W., is exceedingly well disposed to favor the recovery of a lower coal if it is present.

AREA V

The fifth area recommended for special investigation extends six miles east and three miles south of Pinckneyville, in Perry County (Pl. VI). It lies entirely within the area of the Pinckneyville quadrangle, which has not yet been surveyed geologically. The information which is presented herein does not, therefore, represent the results of special investigation, but is a compilation of data available in the literature and in the Survey files. Although it is small in amount it indicates the existence of coal at shallow depth at a number of places so that the recommendation of the area for exploration seems warranted.

In earlier maps published by the Survey and other maps the outcrop of No. 6 coal in this area has been indicated at various positions. In general it has been indicated as extending northward through the west side of sec. 35, T. 5 S., R. 2 W., to the SW. cor. sec. 26, and thence northwest to the SW. ¼ sec. 22, where it crossed Panther Creek. From there it was mapped as swinging southwest passing just north of the drill hole in the SW. ¼ sec. 29 and crossing the main branch of Beaucoup Creek in the north half of sec. 30, from which point it was continued southwest close to the township line at the east side sec. 36, T. 5 S., R. 3 W. Information now available seems to indicate that erosion along Beaucoup Creek and its branches was by no means so extensive as was formerly thought and that the outcrop of the coal lies much nearer the creek than was suspected, and accordingly does not finger up the valleys so far.

The Panther mine, according to information furnished by the State Mine Inspector, mines No. 6 coal at a depth of 54 feet in the vicinity of Denny, sec. 33, T. 5 S., R. 2 W. It is probable therefore, that the margin of the coal is crossed by the creek some distance below the line of the Illinois

Central Railroad and that in general the outcrop lies south of the railroad rather than north of it, at least across sec. 33. The outcrop apparently swings north across the railroad in the N. ½ sec. 32 and southward across the railroad again in the SE. ¼ sec. 30. Worthen[6] in his report on Perry County states that No. 6 coal has been worked in a ravine in sec. 30. He further states: "A half mile northeast of town (Pinckneyville) the coal crops out on the Beaucoup; and several shafts have been sunk to the coal at this point..... There seems to be an undulation in the strata here which brings the main coal above the creek level, just at the town, while it dips below that level above and below." It will be noted that the coal lies at a depth of 29 feet at the Shakerag mine in the SE. ¼ SW. ¼ sec. 26, T. 5 S., R. 2 W., so that it is possibly as much as 30 to 35 feet higher in altitude than it is at the Panther mine. Since there is apparently a southward dip from near Pinckneyville, at the west side of the area, and apparently also a dip in the same direction at the east end of the area it is thought the coal throughout the area dips southward from an axis parallel to the Illinois Central Railroad lying a mile or more northeast of the railroad. Since a large portion of this area lies between 400 and 460 feet above sea level and the slopes are very gentle, conditions seem to be particularly favorable for open-cut mining provided the coal is present at the shallow depth suggested. The fact that the cap rock in this region is relatively heavy is probably an advantage since it served as a protection against preglacial and glacial erosion of the coal bed itself.

Exploration in this region should be directed toward discovering the altitude of the coal along lines running north or northeast from the railroad, particularly in the interstream areas. Since the coal lies at shallow depth, its outcrop will doubtless be very irregular, and yet it is found in other places that irregularities in the outcrop of the coal generally conform to the present topography after allowance is made for about 20 feet of fill. For this reason, inasmuch as the coal lies close to the level of drainage, drilling should be restricted to the divides until the position of the coal is established.

It is not improbable that the area in which the coal lies at an altitude of 400 feet or more extends eastward beyond the boundary of the special area for several miles, at least through sec. 24, T. 5 S., R. 2 W., and sec. 19, T. 5 S., R. 1 W. There appears to be a large area suitable for exploration.

AREA VI

The final special area to be described lies adjacent to the heart of the Williamson County coal field, occupying an area lying between Herrin, Carterville, and Marion (Pl. VII). The particular portion of the area where exploration is recommended lies west of the Chicago, Burlington, and Quincy Railroad, that is between the pit operated by the Pyramid Coal Corporation in sec. 33, T. 8 S., R. 2 E., and Carterville.

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[6] Worthen, A. H., Geological Survey of Illinois, vol. III, p. 90, 1868.

This area includes a part of each of four quadrangles, namely, the Herrin quadrangle on the northwest, the Carbondale quadrangle on the southwest, the West Frankfort quadrangle on the northeast and the Marion quadrangle on the southeast. The geology of each of these areas, except the Marion quadrangle, has been mapped in detail and geological maps of the Herrin and Carbondale quadrangles have been published.[7]

Information in regard to the lay of No. 6 coal is fairly accurate in the portion of the area lying in T. 8 S. Near the outcrop, however, less definite information is available. The outcrop of both No. 5 and No. 6 coals is shown with as much accuracy as possible. The outcrop of No. 6 coal is probably more accurately indicated than that of No. 5 coal, but since the two coal beds are only 25 to 30 feet apart the lines of outcrop will probably not generally be separated more than half a mile. Particular attention is called to the small anticlinal fold exposed along the creek in the SW. ¼ sec. 6, T. 8 S., R. 2 E. The outcrop of No. 5 coal is swung north through the south half of secs. 5 and 6 in accordance with the probabilities with respect to this minor structure.

Areas recommended for exploration are particularly the E. ½ sec. 5 with respect to No. 6 coal, and the S. ½ sec. 1, T. 9 S., R. 1 E., and the W. ½ sec. 9 and the E. ½ sec. 8, T. 9 S., R. 2 E., with respect to No. 5 coal. The outcrop of both coals has been explored from the line of the Chicago, Burlington, and Quincy Railroad east nearly to Harrisburg, and most of the coal is under option or actual ownership of those interested in open-cut mining, so that recommendations for explorations do not apply for this portion of the area. The writer wishes to call attention, however, to the outcrop of No. 5 coal as delineated in the eastern part of the area, since it has not previously been mapped in this region. The line is established by recent drilling for coal suitable for open-cut mining in a large area adjacent to Marion. The boundary of No. 5 coal has not been checked in the field and there is a possibility that the southward extension of the coal into sec. 23 may be due to the confusion of No. 5 coal with a lenticular bed that lies a short distance below No. 5 in some places in the vicinity of Marion. The map is of particular interest because it shows the southward displacement of the outcrop along the fault zone in sec. 10.

Attention may well be directed to the occurrence of a body of coal adjacent on the east to that owned by the Pyramid Coal Corporation and the Carbon Fuel Company, lying in the NW. ¼ sec. 34, T. 8 S., R. 2

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[7] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), 1912.

Lamar, J. E., Geology and mineral resources of the Carbondale quadrangle: Illinois State Geol. Survey Bull. 48, 1925.

E. It will be noted that the altitude of the coal varies from 425 feet along the south line of sec. 34 to about 375 along the north line. The surface slopes in the same direction but more gently than the coal. In this region the cap rock is generally thin or absent, or 25 feet or more above the coal and the rock cover therefore would offer less difficulty in its removal than is commonly the case.

Other Areas

There remain for consideration two areas of relatively small size located along the outcrop of No. 5 and No. 6 coals in southern Illinois beneath which are bodies of coal under shallow cover. These will be considered in the order of their geographic position from east to west.

The first area lies on the west side of the Illinois Central "cut-off" near the Williamson-Saline county line in secs. 35 and 36, T. 9 S., R. 4 E., and in sec. 2, T. 10 S., R. 4 E. The underlying coal is No. 5, and its margin has been traced partly across Saline County to the Williamson County line by Harrisburg interests. The outcrop of the coal probably passes west through the south quarter of sec. 36, swings south and then west again through the SE. ¼ sec. 35 and the north half of sec. 2. In the west half of sec. 2 the cover is heavy close to the outcrop. There is probably between 100 and 150 acres of coal available in this tract and it lies very close to transportation.

A much larger tract than that just described is to be found along the outcrop of No. 6 coal west of Hallidayboro in Jackson County. This tract occupies a position lying between the tracts developed on the north by the Black Servant Coal Company, and on the south by the Forsyth Coal Company. In an area largely confined to the W. ½ sec. 36 and the SW. ¼ sec. 25, T. 7 S., R. 2 W., and the NW. ¼ sec. 1, T. 8 S., R. 2 W., the coal lies at an altitude of 375 feet or above, and the surface has an altitude of between 400 and 420 feet. It is possible that coal may extend southwest into the E. ½ sec. 2, T. 8 S., R. 2 W. Drilling along the margin of No. 6 coal should seek to discover the position of No. 5 coal since it seems probable that it is recoverable by stripping in secs. 26 and 35, T. 7 S., R. 2 W., and 2, T. 8 S., R. 2 W. That No. 5 coal may be present also at shallow depth in sec. 7, T. 8 S., R. 1 W., south of the area occupied by the Forsyth Coal Company, seems probable.

SUPPLEMENTARY DATA ON THE COAL AREA IN WILLIAMSON COUNTY

Since the writing of this report, additional information has been obtained on an area of coal under light cover in sec. 36, T. 9 S., R. 4 E., and in sec. 2, T. 10 S., R. 4 E., Williamson County. This area lies along the Williamson and Saline county line near the southeast corner of Crab

Orchard and the northeast corner of Stonefort townships. The right of way of the Edgewood-Metropolis division of the Illinois Central Railroad lies along the east side of the area. The nearest town, Carrier Mills, is 3½ miles east on the Big Four Railway.

The area is included in the Harrisburg topographic quadrangle, and the mapping of the geology was incident to the preparation of a geological map of that quadrangle. The writer is especially indebted to his assistant, Mr. Lloyd G. Henbest, for the field data and the compilation of the map (Pl. VIII).

About 246 acres of coal is thought to be present in the area under a cover whose thickness has a ratio of 8 to 1 with respect to the thickness of the coal, and an additional 325 acres under a cover with a ratio of 10 to 1. The total tonnage available at an average thickness of 4½ feet of coal is about 4½ million tons.

The outcropping coal is No. 5, the same bed which is extensively mined at Harrisburg, Eldorado, and elsewhere in Saline County. It is an excellent quality of Illinois coal. The cover of the coal is mainly shale, and glacial drift or alluvium. Where the cover is less than 8 to 1, it consists of about one-half unconsolidated material and one-half shale; where the cover is heavier, the drift rarely exceeds 20 feet. In some places, a thin bed of limestone one to two feet thick is found in the shale at various distances above No. 5 coal.

The northern boundary of the strippable area is placed at the outcrop of a thin coal, called "5½" or "5A" (possibly the equivalent of the Briar Hill coal of Kentucky[8]), which lies 50 to 60 feet above No. 5 coal and about the same distance below No. 6 coal.

No. 5 coal in this area is at least 4½ feet thick, and at several places is reported as 4 feet 8 inches thick. Its attitude is nearly horizontal. Probably small local flexures will be found to be of more importance than the general regional northward dip in affecting the depth of overburden.

Plate VIII indicates the area recommended for testing and also shows the locations of coal outcrops and other field data listed in Table 4. It will be noted that the district recommended has three divisions: (1) an area where the cover has a ratio of 8 to 1 with respect to the thickness of the coal; (2) an area where the ratio is between 8 to 1 and 10 to 1; and (3) an area south of the designated outcrop of No. 5 coal within which there may be patches of the coal. The line marking the outcrop of No. 5 coal can be indicated only in a general way. Possibly in places it lies slightly north and in other places south of the designated position. In the tonnage estimates that have been made, possible bodies of coal south of the indicated position of the outcrop of No. 5 coal were not included. The most desirable body of coal, shown by the shaded portion on Plate VIII, probable underlies the eastern part of the area where the ratio of the overburden to the coal is less than 8 to 1.

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[8] Lee, Wallace, Geology of the Kentucky part of the Shawneetown quadrangle: Kentucky Geol. Survey, p. 33, 1916.

About 40 acres of strippable coal was reported to be under option in this tract at the time the data were collected in June, 1927.

TABLE 4.—*Surface data collected in secs. 35, 36, T. 9 S., R. 4 E.; sec. 31, T. 9 S., R. 5 E.; sec. 6, T. 10 S., R. 5 E.; secs. 1, 2, 3, T. 10 S., R. 4 E.*

Numbers correspond to the numbers on the map (Pl. VIII).

Sec. 35, T. 9 S., R. 4 E. (Williamson County)

Map No.
1. Outcrops of No. 5A coal and of shale.
2. No. 5A coal, 10 to 15 feet below surface in shallow well.
3. No. 5 coal at Will Hill drift mine. Surface altitude at mouth about 450 feet. Altitude of top of coal 445 feet. Slight southard dip. Coal 4 feet 8 inches thick.
4. Two shallow wells.

Sec. 36, T. 9 S., R. 4 E. (Williamson County)

1. Outcrop of No. 5A coal.
2. No coal in shallow well.
3. Outcrop of No. 5A coal.
4. Outcrop of black slate near limestone horizon.
5. Water well—exact location uncertain. Surface altitude 440 feet. 27 feet to top of No. 5 coal. Drilled through 6 feet of coal without penetrating bed. (Part of the 6 feet may be black slate.)
6. No information.
7. Drill hole: No. 5 coal at 33 feet; over 4 feet thick.
8. Drill hole: No. 5 coal at 17 feet; 3 feet 7 inches thick.
9. Probably no coal.
10. Drill hole: probably no coal.

Sec. 31, T. 9 S., R. 5 E. (Saline County)

1. Outcrop of No. 5A coal in cut.
2. Drill hole: No. 5 coal at 65 feet.
3. Drill hole: No coal to 51 feet.
4. Probably no coal; shallow well, about 15 feet.

Sec. 6, T. 10 S., R. 5 E. (Saline County)

1. No coal in well; 10 to 20 feet deep.

Sec. 1, T. 10 S., R. 4 E. (Williamson County)

1. Shaly sandstone struck in water well. No coal at 12 feet.
2. Drilled water well; 5 feet of coal reported struck at 165 feet. This is probably No. 2 coal.
3. Well at approximately this location; 21 feet deep with 20 inches of coal at bottom. Probably thin coal between No. 2 and No. 5 coals.
4. Well; no coal.
5. Drilled water well 50 feet deep; no coal.

Sec. 2, T. 10 S., R. 4 E. (Williamson County)

1. Outcrop of shale. Coal in wash, probably from No. 6 coal outcropping on the hill to the north.
2. Struck No. 5A coal in bottom of 16-foot well in barn lot.

3. Outcrop of sandstone in road.
4. Outcrop of shale in road.
5. Old stripping; No. 5A coal.
6. Well 20 feet deep in roof shale of No. 5 (?) coal.
7. Old prospect shaft for lead. Coal penetrated at about 20 feet.
8. Outcrop of limestone over blue shale.
9. Outcrop of shale.
10. Drill hole; coal reported at 33 to 36 feet.
11. Outcrop of shale.
12. Exposure of glacial till.
13. Outcrop of soft sandstone.
14. Exposure of glacial till.
15. Outcrop of soft shaly sandstone.
16. Shallow well; no coal.
17. Shallow well; no coal.
18. Well 40 feet deep; no coal.
19. Well in barn lot 15 to 20 feet below the house. About 35 feet deep; said to have encountered coal.
20. Well 20 feet deep; no information.
21. Well dug mostly in clay; 15 to 20 feet deep.

Sec. 3, T. 10 S., R. 4 E. (Williamson County)

1. Exposure of glacial till.
2, 3. Wells; no coal.
4. Farm well in shale; no coal.
5. Shallow wells; not certain whether coal was encountered.
6. Outcrop of shale and limestone.
7. Well; no coal.
8. Drill hole about 30 feet deep; no coal.
9. Well 12 feet deep in till.
10. Exposures of glacial till.

PUBLICATIONS
ILLINOIS MINING INVESTIGATIONS
Illinois State Geological Survey Division
Urbana, Illinois

Bulletin 1. Preliminary report on organization and method of investigations, 1913.
Bulletin 3. Chemical study of Illinois coals, by S. W. Parr, 1916.
Bulletin 10. Coal resources of District I (Longwall), by G. H. Cady, 1915.
Bulletin 11. Coal resources of District VII, by Fred H. Kay, 1915.
Bulletin 14. Coal resources of District VIII (Danville), by Fred H. Kay and K. D. White, 1915.
Bulletin 15. Coal resources of District VI, by G. H. Cady, 1916.
Bulletin 16. Coal resources of District II (Jackson Co.), by G. H. Cady, 1917.
Bulletin 17. Surface subsidence in Illinois resulting from coal mining, by Lewis E. Young, 1916.
Bulletin 18. Tests on clay materials available in Illinois coal mines, by R. T. Stull and R. K. Hursh, 1917.
Bulletin 19. Coal resources of District V, by G. H. Cady, 1919.
Bulletin 20. Carbonization of Illinois coals in inclined gas retorts, by F. K. Ovitz, 1918.
Bulletin 21. The manufacture of retort coal-gas in the central states, using low-sulphur coal from Illinois, Indiana, and western Kentucky, by W. A. Dunkley and W. W. Odell, 1918.
Bulletin 22. Water-gas manufacture with central district bituminous coals as generator fuel, by W. W. Odell and W. A. Dunkley, 1918.
Bulletin 23. Mines producing low-sulphur coal in the central district, by G. H. Cady, 1919.
Bulletin 24. Water-gas operating methods with central district bituminous coals as generator fuel. A summary of experiments on a commercial scale, by W. A. Dunkley and W. W. Odell, 1919.
Bulletin 25. Gas purification in the medium-size gas plants of Illinois, by W. A. Dunkley and C. E. Barnes, 1920.
Bulletin 26. Coal resources of District IV, by G. H. Cady, 1921.
Bulletin 27A. Analyses of Illinois coals, compiled by G. W. Hawley, 1923.
Bulletin 28. Preliminary report on coal stripping possibilities in Illinois, by Harold E. Culver, 1925.
Bulletin 29. Coal resources of District III, by Harold E. Culver, 1925.
Bulletin 30. Coal losses in Illinois, by C. A. Allen, 1925.
Bulletin 31. Coal stripping possibilities in southern and southwestern Illinois, by G. H. Cady, 1927.

Engineering Experiment Station
Urbana, Illinois

Bulletin 2. Coal mining practice in District VIII (Danville), by S. O. Andros, 1913.
Bulletin 4. Coal mining practice in District VII, by S. O. Andros, 1914.
Bulletin 5. Coal mining practice in District I (Longwall), by S. O. Andros, 1914.
Bulletin 6. Coal mining practice in District V, by S. O. Andros, 1914.
Bulletin 7. Coal mining practice in District II, by S. O. Andros, 1914.
Bulletin 8. Coal mining practice in District VI, by S. O. Andros, 1914.
Bulletin 9. Coal mining practice in District III, by S. O. Andros, 1915.
Bulletin 12. Coal mining practice in District IV, by S. O. Andros, 1915.
Bulletin 13. Coal mining in Illinois, by S. O. Andros, 1915. (Complete resumé of all the district reports.)
Bulletin 91. Subsidence resulting from mining, by L. E. Young and H. H. Stoek, 1916.
Bulletin 100. Percentage of extraction of bituminous coal with special reference to Illinois's conditions, by C. M. Young, 1917.
Bulletin 113. Panel system of coal mining, by C. M. Young, 1919.
Bulletin 119. Some conditions affecting the usefulness of iron oxide for city gas purification, by W. A. Dunkley, 1921.
Bulletin 125. The distribution of the forms of sulphur in the coal bed, by H. F. Yancey and Thomas Fraser, 1921.
Bulletin 132. A study of coal mine haulage in Illinois, by H. H. Stoek, J. R. Fleming and A. J. Hoskin, 1922.
Bulletin 144. Power studies in Illinois coal mining, by A. J. Hoskin and T. Fraser, 1924.
Bulletin 151. A study of skip hoisting in Illinois coal mines, by A. J. Hoskin, 1925.
Bulletin 158. Measurement of air quantities and energy losses in mine entries, by A. C. Callen and C. M. Smith, 1926.

U. S. Bureau of Mines
Washingon, D. C.

Bulletin 72. Occurrence of explosive gases in coal mines, by N. H. Darton, 1915.

Bulletin 83. The humidity of mine air, by R. Y. Williams, 1914.

Bulletin 99. Mine ventilation stoppings, by R. Y. Williams, 1915.

Bulletin 102. The inflammability of Illinois coal dusts, by J. K. Clement and L. A. Scholl, Jr., 1916.

Bulletin 137. Use of permissible explosives in the coal mines of Illinois, by J. R. Fleming and J. W. Koster, 1917.

Bulletin 138. Coking of Illinois coals, by F. K. Ovitz, 1917.

Bulletin 203. Central district bituminous coals as water-gas generator fuel, by W. W. Odell and W. A. Dunkley, 1924.

Bulletin 234. The screen sizing of coal, ores and other minerals, by E. A. Holbrook and Thomas Fraser, 1924.

Bulletin 238. Subsidence due to coal mining in Illinois, by C. A. Herbert and J. J. Rutledge, 1927.

Technical Paper 190. Methane accumulations from interrupted ventilation, with special reference to coal mines in Illinois and Indiana, by H. I. Smith and Robert J. Hamon, 1918.

Technical Paper 246. Water-gas apparatus and the use of central district coal as generator fuel, by William W. Odell, 1921.

Technical Paper 268. Preparation and uses of tar and its simple crude derivatives, by W. W. Odell, 1922.

Technical Paper 284. Coal and coke mixtures as water-gas generator fuel, by W. W. Odell, 1921.

Technical Paper 304. Water-gas tar emulsions, by W. W. Odell, 1923.

Technical Paper 326. Fires in steamship bunker and cargo coal, by H. H. Stoek, 1923.

Technical Paper 330. Small hose streams for fighting mine fires, by L. D. Tracy and R. W. Hendricks, 1924.

Technical Paper 332. Conditions affecting the activity of iron oxides in removing hydrogen sulphide from city gas, by W. A. Dunkley and R. D. Leitch, 1924.

Technical Paper 335. Bituminous coal as generator fuel in large water-gas sets with waste-heat boilers, by W. A. Dunkley, 1925.

Technical Paper 361. Cleaning tests of central Illinois coal, by Thomas Fraser and H. F. Yancey, 1925.

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

Cooperative Mining Series
BULLETIN 32

COAL STRIPPING POSSIBILITIES IN SALINE AND GALLATIN COUNTIES NEAR EQUALITY

BY
LLOYD G. HENBEST

ILLINOIS MINING INVESTIGATIONS

Prepared under a cooperative agreement between the Illinois State Geological Survey Division, and the Engineering Experiment Station of the University of Illinois

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PLATE

I. Map of portion of Saline and Gallatin counties showing outcrop of No. 5 and No. 6 coals and data regarding the thickness of the overburden......In pocket

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COAL STRIPPING POSSIBILITIES IN SALINE AND GALLATIN COUNTIES NEAR EQUALITY

By Lloyd G. Henbest

INTRODUCTION

In Saline and Gallatin counties within a short distance of the town of Equality are several areas underlain by coal at shallow depths. The various tracts include about 6000 acres and represent a total of more than 40,000,000 tons of coal. Although mining companies have owned the deeper coal for several years, but little interest has been taken in the possibility of recovery of the coals along their outcrops by open-cut mining. Examination shows, however, that conditions for coal recovery are probably as favorable as they are in other regions where strip-mining methods have been successfully employed.

In the area of this report, five tracts which are described separately are recommended for prospecting. Two tracts of No. 6 coal and one of No. 5 lie north of the Cottage Grove fault, and one tract each of Nos. 5 and 6 coal lies to the south of the fault.

ACKNOWLEDGMENTS

This report was prepared under the direction of Dr. Gilbert H. Cady, Senior Geologist, Illinois State Geological Survey, as a part of the Survey's investigations of coal stripping possibilities in the State.[1] Some of the field data were collected by Mr. Louis McCabe.

SOURCES OF INFORMATION

The geologic data which form the basis of this report were obtained from records of coal test borings and water wells and from field observations. The records of coal test borings in the western and northern parts of the area were supplied by the O'Gara Coal Company, Saline County Coal Corporation, and Wasson Coal Company, all of Harrisburg. For information about coal near Equality the writer is indebted to Dr. L. W. Gordon, physician at Equality, who shared the data that he and Mr. Hugh Murray, also of Equality, have been collecting for several years.

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[1] Other reports on coal stripping possibilities in Illinois are:

Culver, H. E., A preliminary report on coal stripping possibilities in Illinois: Illinois State Geol. Survey Mining Investigations Series Bull. 28, 1925.

Cady, Gilbert H., Coal stripping possibilities in southern and southwestern Illinois: Illinois State Geol. Survey Mining Investigations Series Bull. 31, 1927.

The rest of the geologic data were obtained from farm wells, local coal mines, and outcrops of coal beds or of rocks that have a known position relative to the coal beds. There are but few outcrops in the area of this report.

The geologic information is summarized on the map (Plate I) and in the Table of Field Data, pages 18-26.

TOPOGRAPHY[2]

The areas recommended for testing are mostly lowlands bordering Saline River and its tributaries. Those portions of the tracts rising above the lowland are low, rolling hills. In the hills the bedrock is close to the surface, but in most of the lowland tracts the bedrock is deeply buried under alluvium.

The alluvial plains lie at elevations between 340 and 380 feet. The average water level at the junction of North Fork and Saline River is estimated at about 330 feet. The gradient of Saline River is low, causing a slow run-off. Sudden and heavy rains occasionally flood the lowlands to a shallow depth, but only exceptional floods such as that of 1913 would seriously interfere with strip mining in any of the areas recommended for testing. With proper precautions all danger from floods could readily be avoided. Among the lowland areas, those most favorable for open-cut mining are least endangered by possibility of inundation.

GENERAL GEOLOGY

STRATIGRAPHY[3]

The rocks exposed in the vicinity of Equality belong to two quite different groups of rock formations. The lower group is the coal-bearing or Pennsylvanian system and the upper or mantle rock belongs to the Pleistocene (glacial) and Recent systems.

The Pennsylvanian rocks are much the older and are subdivided into the Pottsville, Carbondale, and McLeansboro formations, named in the order of deposition. The Pennsylvanian rocks are mostly shales and sandstones but include beds of limestone, clay, and coal. Numerous coal beds exist throughout the Pennsylvanian strata, but only a few are thick enough to be mined under present economic conditions. In the vicinity of Equality the thickest beds of coal are in the Carbondale formation. The Herrin (No. 6) coal is at the top and the Harrisburg (No. 5) coal is 110 to 120 feet below the top of the formation. The Herrin coal is locally known as "No. 7" and the "Bench Coal".

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[2] The areas described are included in the south part of Eldorado quadrangle and the north part of Equality quadrangle topographic maps which may be obtained for ten cents each by addressing a request to the Chief, State Geological Survey, Urbana, Illinois, or to the Director, U. S. Geological Survey, Washington, D. C.

[3] The Pennsylvanian rocks are described in greater detail in the following reports:

Cady, G. H., Coal resources of District V: Illinois State Geol. Survey Coal Mining Investigations Bull. 19, 1919.

Butts, Charles, Geology and mineral resources of the Equality-Shawneetown area: Illinois State Geol. Survey Bull. 47, 1925.

The mantle rock of the region is alluvium which varies greatly in thickness and composition, depending upon the topographic position of the deposits. In the valleys the alluvium is composed of gravel, sand, clay, and possibly some loess,[4] in various associations. The thickness is greatest in Saline River valley south and southwest of Equality where in places it exceeds 100 feet. The mantle rock in the upland and hilly tracts is mostly loess but consists partly of residual clay, sand, and gravel derived by weathering processes from the Pennsylvanian rocks. The loess has an average thickness of about 10 feet, though in some places it may be as much as 20 feet thick.

IGNEOUS ROCKS

Igneous dikes have been encountered in coal mines near Harco, Carrier Mills, Harrisburg, and Eldorado. The only dike known within this area was encountered in Mine No. 6 of the Saline County Coal Corporation at the west side of sec. 35, T. 8 S., R. 7 E. It trends N. 20°± W., and has been traced about three-fourths of a mile in this mine. Apparently the same dike was penetrated in Mine No. 8 of the O'Gara Coal Company in the SW. ¼ sec. 22, T. 8 S., R. 7 E.

The dikes commonly are accompanied by little or no vertical displacement; however, they may be associated with the system of faults that are nearly parallel to them although the dikes and faults are not known to be so associated.

The dike in Mine No. 6 is about 8 feet thick (exclusive of minor extensions) at the base of the coal bed, but widens out to about 20 feet at the top of the coal. The dike probably does not greatly exceed these dimensions at any place. The zone of altered coal is not more than 25 feet wide.

No surface exposures of dikes have been found in Saline and Gallatin counties north of the hills although efforts have been made to discover them above places where they have been encountered in coal mines. The dike rock is thought to be very deeply weathered, an opinion supported by the composition of similar rock exposed in Hardin County.

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[4] Loess is a wind-transported, ocher-yellow silt that commonly contains fossil snail shells.

If dikes exist in the areas recommended for prospecting, they probably are too deeply weathered and too narrow to affect stripping operations seriously.

STRUCTURE

The rock layers in most of the area are inclined northward 50 to 100 feet per mile but local variations occur near faults.

An anticlinal structure in the NW. ¼ T. 9 S., R. 7 E., lies between Grayson, Cottage Grove, and Equality and is terminated on the south by the Cottage Grove fault. The anticlinal structure is indicated by the altitude of the coal in several wells and by the dip of the coal in the mine at Grayson. The outline of the anticline is delineated fairly well by the northward swing of the outcrop of No. 6 coal (Pl. I). The steepest dip is toward the north.

The Cottage Grove fault is supposed to be about 12 miles long, extending from near Equality through a mine north of Harrisburg. The maximum displacement is in secs. 14 and 15, T. 9 S., R. 7 E., where No. 6 coal is displaced vertically 185 feet between two points about 2000 feet apart. This displacement causes a repetition of the outcrop of No. 6 coal north and south of the fault.

A fault was encountered near the center of the E. ½ sec. 35, T. 8 S., R. 7 E., when the main east entry was being driven for Mine No. 6 of the Saline County Coal Corporation, but it is not known to extend to the line of outcrop. The downthrow is said to be on the east and the displacement is reported as 12 feet.

AREA 1

No. 6 COAL NORTH OF EQUALITY

LOCATION AND TRANSPORTATION FACILITIES

North of Equality and east of the Louisville and Nashville Railroad (Pl. I), in secs. 1 and 2, T. 9 S., R. 7 E., and in secs. 3 to 10, T. 9 S., R. 8 E., is about 2400 acres of No. 6 coal in which the overburden is less than ten times the thickness of the coal. An additional 1000 or more acres of coal has an overburden ten to fourteen times the thickness of the coal.

Two railroads are near the tract recommended for prospecting. The Louisville and Nashville Railroad crosses the west end of the area as mentioned above and the Shawneetown division of the Baltimore and Ohio Railroad which extends from Beardstown to Shawneetown is about two miles from the east end. No place in the tract is more than three miles from a railroad.

THICKNESS AND CHARACTER OF THE COAL

No. 6 coal in this tract is thought to have the common thickness of 4½ feet. This is the thickness reported for two drill holes in sec. 1, T. 9 S., R. 7 E., and for two drill holes in sec. 4, T. 9 S., R. 8 E. One drill hole in the former section is reported to have passed through 4 feet 10 inches of coal. Estimates of the strip-coal resources of this area are based on an assumed thickness of 4½ feet.

In most of the area the coal is probably well preserved from the effects of weathering by a covering of shale which separates the coal from the limestone cap rock and the porous sandstone above. This sandstone, because of its porosity, does not protect the coal from weathering as does the shale, especially where the hard rock cover is only a few feet thick.

A water well, not shown on the map, and a test boring for No. 6 coal in the NW. ¼ sec. 9, T. 9 S., R. 8 E., located about 500 to 600 feet apart in a north-south direction, are both reported to have encountered decayed coal. The belt of weathered coal is thought to be exceptionally wide here because the sandstone extends to or nearly to the top of the coal and cuts out the usual shale cover. At the exposure of No. 6 coal in the bed of North Fork, Saline River, NE. ¼ sec. 9, T. 9 S., R. 8 E., the sandstone lies directly upon the coal. Here, however, the sandstone is thick and the coal appears to be well preserved.

THICKNESS AND CHARACTER OF THE OVERBURDEN

The overburden in the upland and intermediate tracts is mostly loess. The usual thickness of the loess is 10 to 15 feet but it may vary considerably. East of North Fork, Saline River, the loess is widely distributed and probably composes a large part of the alluvium. In the lowlands the upper 10 to 30 feet of the overburden is alluvium.

The lower portion of the overburden is consolidated rock. Sandstone composes about one-third to two-thirds and limestone and shale the rest wherever the cover of solid rock is less than 40 feet thick. The shale is more or less sandy. The limestone varies up to six feet thick, averaging about three feet. The limestone is close above the coal and is commonly called the cap rock of No. 6 coal. It has been named the Herrin limestone by Cady.[5] The sandstone is massive, cross-bedded and friable and is believed to form fully half of the entire cover in secs. 4 and 9, T. 9 S., R. 8 E.

The great thickness of sandstone above No. 6 coal is the chief impediment to profitable stripping in the area. The hardness of the sandstone varies from place to place because of differences in its composition and also because of variations in weathering and secondary cementation.

ESTIMATE OF RESOURCES

The following table shows the probable acreage and amount of strippable coal in each section. The thickness is assumed to be 4½ feet and the acre-tons 7965.

TABLE 1.—*Resources of coal No. 6 north of Equality*

Location			Cover $\frac{0}{1}$ to $\frac{8}{1}$		Cover $\frac{8}{1}$ to $\frac{10}{1}$		Cover $\frac{10}{1}$ to $\frac{14}{1}$	
Sec.	Twp. S	Range E	Acres	Tonnage[b]	Acres	Tonnage[b]	Acres	Tonnage[b]
3[a]	9	8	60	478,000	100	796,000	95	757,000
4	9	8	120	956,000	103	820,000	400	3,186,000
5	9	8	60	478,000	125	996,000	190	1,513,000
6	9	8	140	1,115,000	85	677,000	160	1,274,000
7	9	8	255	2,031,000	155	1,235,000	..	......
8	9	8	85	677,000	5	40,000	..	......
9[a]	9	8	175	1,394,000	13	104,000	..	......
10	9	8	155	1,235,000	95	757,000	70	558,000
11	9	8	50	398,000	35	279,000	35	279,000
14	9	8	130	1,035,000	..	......	..	......
1	9	7	235	1,872,000	120	956,000	85	677,000
2	9	7	45	358,000	35	279,000	..	......
12	9	7	30	239,000	45	358,000	..	......
		Total	1540	12,266,000	916	7,297,000	1035	8,244,000

Grand total: 3491 acres; 27,807,000 tons.

a Area very uncertain.
b To the nearest thousand.

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[5] Cady, Gilbert H., The areal geology of Saline County: Trans. Illinois State Acad. Sci., vol. 19, pp. 250-273, 1926.

AREA 2

No. 6 Coal North of the Cottage Grove Fault

LOCATION AND TRANSPORTATION FACILITIES

North of the Cottage Grove fault and west of the Louisville and Nashville Railroad is a tract of 1400 to 1500 acres where the overburden is less than 50 feet thick. This area is in sections 2, 3, 9, 10, 11, and 14, T. 9 S., R. 7 E., Saline County. The belt of shallow coal is about three miles long and half a mile wide.

The whole tract lies within three miles of the Louisville and Nashville Railroad. The west end of the tract is three and a half miles from the Cleveland, Cincinnati, Chicago, and St. Louis Railroad, Cairo division.

THICKNESS AND CHARACTER OF THE COAL

No. 6 coal is 4 to 5 feet thick in this area, the average is probably 4 feet 8 inches. Coal of this thickness will provide 8000 tons per acre if it is entirely recovered. At the abandoned Davis mine, near the center of the NE. ¼ SW. ¼ SE. ¼ sec. 10, T. 9 S., R. 7 E., two thin clay seams were reported to be present in the coal. Records of drilling in the area do not, however, indicate the presence of important clay seams in the coal. Even the characteristic "blue band" which ordinarily lies about one foot above the bottom of the coal seam is not recorded, although it is probably present.

There appears to be no available information about the chemical character of No. 6 coal in this general region, but it is supposed to be somewhat higher in ash and sulfur than No. 5 coal which is more commonly mined in the Equality-Cottage Grove region.

THICKNESS AND CHARACTER OF THE OVERBURDEN

The character of the overburden varies greatly because the present land surface does not correspond, except in a general way, to the surface of the hard rocks below the alluvium and yellow silt; therefore, in the absence of records from closely spaced test-borings, it is impossible to make accurate estimates of the kind and the amount of overburden. The overburden where less than eight times the thickness of the coal consists on the average of about one-third clay and silt, one-half shale and sandstone, and one-sixth limestone and "slate". On the uplands a considerable part of the limestone cap rock is probably separated into blocks, due to solution by ground-water along joint-cracks.

Such blocks could probably be removed without much blasting. The cap rock is thought to be exposed in a ditch in the SE. ¼ SE. ¼ sec. 2, T. 9 S., R. 7 E. In the Davis mine, mentioned above, the black "slate" or shale roof of the coal bed contains large concretions or "niggerheads". The weathered limestone and the concretionary shale make a poor roof for shallow subsurface mining. The maximum thickness of the first bed of sandstone above the coal as shown by drill records is 25 feet, and the minimum thickness recorded is less than 15 feet. The sandstone is poorly cemented and not very hard.

Where the overburden of hard rock exceeds 40 feet a second limestone and sandstone occur. The second limestone is probably the Bankston Creek limestone of the Harrisburg region. This limestone is thin but is persistent in certain localities. It may be observed in outcrop along the road near the center W. ½ sec. 9, T. 9 S., R. 7 E., where the base of the overlying sandstone is also exposed. The full thickness of the upper sandstone is possibly as much as 15 feet. It is thought to be lenticular and would probably not be encountered everywhere in the same thickness.

ESTIMATE OF RESOURCES

The area underlain by No. 6 coal, in which the overburden is less than eight times as thick as the coal, is estimated at about 970 acres and the coal resources are about 8,000,000 tons. In addition there are about 500 acres in which the overburden is between eight and ten times the thickness of the coal and in which the coal resources are about 4,000,000 tons.

AREA 3

No. 6 Coal South of the Cottage Grove Fault

Attention has already been directed to the extension of No. 6 coal south of the Cottage Grove fault and west of Equality as shown on Plate I. Most of this coal is known to be concealed beneath a thick cover of alluvium, but small areas were found that have an overburden less than eight times the thickness of the coal.

LOCATION AND TRANSPORTATION FACILITIES

The outcrop of No. 6 coal extends through secs. 14 to 22, T. 9 S., R. 7 E., and sec. 13, T. 9 S., R. 6 E., but neither of the small areas of strippable coal extends into secs. 13 and 14 (Pl. I).

The areas are two to four and a half miles from the Louisville and Nashville Railroad and are four to five miles from the Cleveland, Cincinnati, Chicago and St. Louis Railroad, Cairo division.

THICKNESS AND CHARACTER OF THE COAL

The thickness of the coal ranges from 4 to 5 feet. An exceptional thinness of 29 inches was reported in sec. 18, but it is probable that the average thickness is 4½ feet. The estimates of resources are based upon that thickness.

THICKNESS AND CHARACTER OF THE OVERBURDEN

Where the overburden is less than 50 feet thick about two-fifths of it is composed of yellow silt and alluvium and the rest is hard rock. The hard rock consists of a lenticular, cross-bedded sandstone, 0-25 feet thick, averaging 10 feet; limestone 0-6 feet thick, averaging 3-4 feet; and shale. The sandstone is notably variable in thickness and probably also in hardness. The presence and character of the sandstone can not be predicted except by systematic exploration with a drill. The limestone is absent in some places and may be absent where the sandstone is thickest.

ESTIMATE OF RESOURCES

In secs. 17, 18, 19, and 20, T. 9 S., R. 7 E., it is estimated that there are about 240 acres of No. 6 coal where the cover is less than 35 feet thick. The thickness of No. 6 coal is assumed to be 4½ feet, which makes 7965 acre-tons of coal; therefore the amount for 240 acres is almost 2,000,000 tons. In the same vicinity about 185 acres of coal lie at a depth of 35 to 45 feet. The total resources of this area are almost 1,500,000 tons. The total estimate of all the coal at a depth of less than 45 feet is about 3,400,000 tons.

In secs. 15, 16, 21, and 22, is an area of 100 acres where the cover over No. 6 coal is less than 35 feet thick, and 120 acres where it is between 35 and 45 feet thick. Under the 100-acre area there are about 796,000 tons of coal. Under the 120-acre area there are about 956,000 tons. The total resources of the area recommended for testing then are about 1,750,000 tons. The figures for the acreage are considered to be nearer a maximum than a minimum estimate.

AREA 4

No. 5 Coal South of the Cottage Grove Fault

LOCATION

In secs. 19, 20, 21, and 22, T. 9 S., R. 7 E., No. 5 coal outcrops under the thick alluvium of the Saline River valley. The line of outcrop is shown on Plate I.

THICKNESS AND CHARACTER OF THE COAL

The usual thickness of the coal is from 4 to 5 feet. An exceptional thickness of 8 feet was found in one test hole located in sec. 21, T. 9 S., R. 7 E., but in sec. 19 two tests showed respectively only 12 and 26 inches. These wide differences have been disregarded and the estimates of tonnage given below are based on an assumed average thickness of 4½ feet or 7965 acre-tons.

THICKNESS AND CHARACTER OF THE OVERBURDEN

The overburden is nowhere less than ten times the thickness of the coal and only in a very small area is the ratio less than 12:1. About 450 acres of coal are overlain by an overburden less than twenty times the thickness of the coal.

The cover is composed mainly of alluvium. At the south margin of coal No. 5 the alluvium is 90 to 120 feet thick, and the same thickness probably continues northward except near the low hills that stand as islands of Pennsylvanian rocks in the surrounding alluvium. Wherever the coal remains covered by the original rocks it is probably of good quality, because the roof shales of the coal are almost impervious to water. No very hard rocks exist in the 450-acre tract, if the roof is of the usual kind.

ESTIMATE OF RESOURCES

The coal present beneath the 450-acre tract in the S. ½ secs. 19, 20, and 21 is estimated to be over 3,500,000 tons. Most of the coal is owned by the O'Gara Coal Company.

AREA 5

No. 5 Coal North of the Cottage Grove Fault

LOCATION AND TRANSPORTATION FACILITIES

Due to the anticlinal structure in the NE. ¼ T. 9 S., R. 7 E., described on page 10, No. 5 coal probably rises nearly to the surface in the central portion of secs. 12 to 14, and in sec. 18, T. 9 S., R. 8 E. The area is crossed by the Louisville and Nashville Railroad.

THICKNESS AND CHARACTER OF THE COAL

The thickness and character of the coal can be predicted only on the basis of records of tests and mining operations in adjacent areas.

From this informaton the coal is estimated to be between 4 and 5 feet thick. It is possible that the coal in parts of this area may be much fractured and affected by igneous activity and faults.

THICKNESS AND CHARACTER OF THE OVERBURDEN

The absence of any reliable sources of information within the tract makes it impossible to predict accurately the thickness and character of the overburden. Judging by adjacent areas where the conditions are well known, most of the overburden is thought to be alluvium and the rest shale. There are probably no thick sandstones or limestones where the cover of Pennsylvanian rocks is less than 30 feet thick. The total thickness of the overburden is probably not less than 35 feet at any place.

ESTIMATE OF RESOURCES

It appears possible that there are 300 to 600 acres of coal at a depth of less than 60 feet in this area. If the supposition is correct, the resources of shallow coal are from 2,000,000 to 5,000,000 tons.

Due emphasis should be placed on the fact that in estimating the resources and position of No. 5 coal in this tract no direct or reliable information about the coal was obtainable. The structure and position of No. 5 and No. 6 coals in the adjacent areas are almost the only basis for recommending the testing of this tract.

TABLE 2.—*Field data*

Location Township Sec.	¼	¼	Company and Description	Altitude of surface	Elevation method	Depth to coal		Thickness of coal				Altitude of coal	
						No. 6	No. 5	No. 6		No. 5		No. 6	No. 5
				Feet		*Feet*	*Feet*	*Feet*	*In.*	*Feet*	*In.*	*Feet*	*Feet*
GALLATIN COUNTY Equality T. 9 S., R. 8 E.													
1	NE	NW	Community coal test	350	Est.	140	255	..	..	..	..	210	95
2	Near center			385	Est.	99	....	..	..	..	..	286	....
3	Center E. side	SE	Farm well, thin coal at 40 feet	410	Est.	150	....	4	6	..	..	260	....
4	SW	SE	Coal test	370-375	Est.	28	....	4	2	..	..	342-347	....
4	SW	SW	Farm well	405	Est.	60	....	..	..	..	..	345	....
4	SE	NW	Coal test	....	....	60	....	..	..	..	..	....	....
5	SW corner		Coal test	358	Est.	....	....	E		..	..	....	....
5	SE	NE	Farm well	....	....	70	....	4	6	..	..	....	....
5	NE	NE	Coal test, No. 5a coal at 125 feet	365	Est.	66	187	4	3	?		299	178
6	SE	SE	Coal test	363	Est.	30	....	?		..	..	333	....
7	NE	SW	Coal test	395	Est.	....	169	..	..	5	3	....	226
8	Near center	NW	Coal test	354	Est.	....	....	E		..	..	....	....
9	SW	NW	Coal test, hand drill	365?	Est.	No information	....	..	..	..	..	....	....
9	NE	NW	Coal test, hand drill	365	Est.	23	....		18	..	..	342	....
9	NW	NE	Drift mine, local. Coal No. 6 outcrops in river bed	340	Est.	....	....	4	5	..	..	340	

9	NW	NE	Strip mine, local. Coal No. 6 near river	345	Est.	....	....	.. ..	.. ..	345	....
10	SW	NW	Shaft mine, local, abd., well drilled in shaft	360	Est.	41	161	?	4 2	319	199
10	Center	NW	Slope mine, not completed, abd.	375	....	?	....	?	.. ..	....	....
13	SE	SE	Local mine, coal No. 5a	....	....	....	....	.. ..	.. ..	....	....
13	SW	NW	Farm well	410	Est.	....	165	.. ..	.. ..	....	245
14	SW	SW	Drift mine, local, abd.	365	Est.	....	....	.. ..	?	....	....
14	NE	SW	Air shaft, Hickory Hill Mine, depth not known	420	Est.	....	....	.. ..	.. ..	....	....
14	Center	E½	Coal test	380	....	....	116	.. ..	?	....	264
14	NW	SE	School District water well	425	Est.	....	65	.. ..	4 6	....	360
14	SE	NW	Farm well, coal No. 5a at 78 feet	410	Est.	....	....	.. ..	.. ..	....	....
14	SE	NW	Hickory Hill Mine, pump exhaust hole	400	Est.	....	126	.. ..	?	....	274
14	NW	SW	Hickory Hill Mine, coal test	375	Est.	....	103	.. ..	?	....	372
15	SE	NW	Gallatin Coal and Coke Co., alluvium 67 feet deep	....	....	....	....	E	E	....	....
16	Center	NW	Well for bridge abutment, coal No. 5a	340	Est.	....	....	.. ..	.. ..	....	....
16	NW (NW corner)[a]	NW	Drift mine, local, abd., coal No. 6	385	Est.	5-10	....	.. ..	.. ..	385±	....
16	NW (SW corner)	NW	Drift mine, local, abd., coal No. 6	375	Est.	5-10	....	.. ..	.. ..	370±	....

Abbreviations: Est., estimated; c, confidential; E., eroded; NDE, not deep enough; abd., abandoned.

[a] Shown on Plate I in SW. corner sec. 9.

TABLE 2.—*Field data*—continued

Location Township Sec.	¼	¼	Company and Description	Altitude of surface	Elevation method	Depth to coal No. 6	Depth to coal No. 5	Thickness of coal No. 6		Thickness of coal No. 5		Altitude of coal No. 6	Altitude of coal No. 5
				Feet		*Feet*	*Feet*	*Feet*	*In.*	*Feet*	*In.*	*Feet*	*Feet*
GALLATIN COUNTY Equality T. 9 S., R. 8 E.													
16	NW	NW	Drift mine, local, abd., coal No. 6	385	Est.	10	....	..	..	..	..	375±	....
16	SW	NW	Shaft mine, cooperative local	372	Est.	....	130?	..	..	4	6±	....	....
16	NW	SW	Drift mine, local, abd., coal No. 6	....	....	....	....	..	..	4	..	....	....
16	SW	SW	East Side Mine, coal No. 5	362	Level	....	32	..	..	4	7	....	330
16	SW	SW	Equality Sisk, Mine No. 6, drift	460	Est.	?	....	..	..	4	..	....	....
17	NE	NE	Drift mine, local, abd., No. 6	395	Est.	10±	....	?		..	..	385	....
17	SE	SE	Outcrop, coal No. 5a 32½ inches thick	....	....	....	....	..	..	..	..	....	....
13	SE	SE	West Side Mine	377	....	....	94	..	..	4	8	....	283
20	NW	NW	Shaft mine, abd.	....	....	....	....	..	..	..	..	....	....
23	NE	NW	Drift mine; Hickory Hill, dip is about 3°N.	390	Est.	....	....	..	..	4	4 (Average 56")	....	382

Eldorado T. 8 S., R. 7 E.											
34	NE	NW	O'Gara Coal Co. 5	385	Level	183	303	6 ..	5 ..	202	82
34	SE	NE	Saline County Coal Corp., Mine No. 6 or Grayson Mine	408	Level	....	332	.. ..	.. ..	....	74
35	SW	NE	Saline County Coal Corp., coal test	423.10	Level	....	359	.. ..	.. ..	....	64.10
35	W side		Igneous dike in mine, coal disturbed	....	....	....	....	.. ..	.. ..	....	....
36	SW	SW	Saline County Coal Corp., coal test	380	Level	156	278	c	c	224	102
36	SE	SE	Water well, 36 feet deep, stopped on coal No. 8?	....	....	....	...	.. ..	.. ..	....	....
SALINE COUNTY Cottage Grove T. 9 S., R. 7 E.											
1	NE	NW	Farm well	....	....	45?	NDE	.. ..	.. ..	....	....
1	SE	NW	Leper mine, local	377	Level	53	NDE	4 2	.. ..	324	....
1	SW	NW	Swinney mine, local	386	Level	43	NDE	4 6	.. ..	343	....
1	SE	NW	Farm well	....	....	32	NDE	4 ..	.. ..	....	....
1	NE	SW	Drill hole	....	....	21	NDE	4 10	.. ..	....	....
1	Center	S½	Farm well	....	....	25½	NDE	4 10	.. ..	....	....
1	Center	S½	Farm well	....	....	20	NDE	1 6	.. ..	....	....
1	SE	SW	Well, 30 feet deep	....	....	....	....	E	.. ..	....	....
2	NW	NW	Drill hole	380	Est.	165±	279±	.. ..	.. ..	215	101
2	SW	NE	Drill hole	....	....	80	....	3 8	.. ..	....	....
2	SE	NE	Well, 30 feet deep	....	....	NDE	NDE	.. ..	.. ..	....	....
2	NW	SE	Local mine, abd.	....	....	?	NDE	?	.. ..	....	....

Abbreviations: Est., estimated; c, confidential; E., eroded; NDE, not deep enough; abd., abandoned.

TABLE 2.—*Field data*—continued

Location Township Sec.	¼	¼	Company and Description	Altitude of surface	Elevation method	Depth to coal No. 6	Depth to coal No. 5	Thickness of coal No. 6		Thickness of coal No. 5		Altitude of coal No. 6	Altitude of coal No. 5
				Feet	*Feet*	*Feet*	*Feet*	*Feet*	*In.*	*Feet*	*In.*	*Feet*	*Feet*
SALINE COUNTY **Cottage Grove** **T. 9 S., R. 7 E.**													
2	Center SW		Cap rock coal No. 6, outcrop	....	....	....	....	..	..	..	..	....	....
3	NE	NW	Whoolery 26	370	Level	128	247	c		c		242	123
4	NE	NW	Lancaster C-1	365	Est.	132	251	5	..	3	9	233	114
4	SW	SE	Whoolery 25	365	Est.	98	215	5	..	4	6	267	150
5	NW	NE	Lancaster C-2	370	Level	161	283	2	..	5	..	209	87
5	NW	SW	Danforth 1	370	Est.	138	266	6	4	4	10	232	104
5	SW	SE	Whoolery 24	370	Est.	101	224	4	6	5	3	269	146
6	SE	NE	Whoolery 23	370	Est.	144	268	4	7	4	10	226	102
7	SE	NW	Whoolery 10	368	Est.	128	251	3	9	4	7	240	117
8	NE	SW	Danforth 25	368	Level	176	NDE	c		..	..	192	....
9	Center	W½	Outcrop of Bankston Creek limestone	385	Est.	40±	....	..	..	..	..	345±	....
9	SW	NE	Farm well, Bankston Creek limestone at 10 feet	400	Est.	50±	....	..	..	..	..	350±	....
9	NW	SE	Farm well, Bankston Creek limestone at about 10 feet	430	Est.	50±	....	..	..	..	..	380±	....
9	SE	NE	Bridgett 5, coal test	380	Est.	53	c	c		c		327	....
10	NE	NW	Whoolery 28, coal test	377	Est.	75	c	c		c		302	....

10	NE	SW	Saline County Coal Corp. 154, coal test	425	Est.	36	155	4 ..	4 6	389	270
10	SW	SE	Davis Mine, local, abd., No. 6	425	Est.	10?	....	4 8	.. ..	415±	...
11	SW	NW	Bridgett 2, coal test	398	?	33	150	c	c	365	248
11	NE	SW	Bridgett ?, coal test	425	Est.	?	150	.. ..	.. ..	....	275
11	NE	NW	Coal test	378	Est.	?	160	.. ..	.. ..	....	218
11	SW	SW	Outcrop of coal No. 6 at road corner	....	Est.	....	....	.. ..	.. ..	430	....
12	NW	NE	Coal test	395±	Est.	35-40	160	Thin	5 6	355-60	235±
12	NW	NE	Farm well, 15 feet deep, no coal	....	....	....	....	.. ..	.. ..	....	....
12	NE	NE	Farm well, 35 feet deep, no coal	....	....	....	....	.. ..	.. ..	....	....
13	Center	NW	Farm well, 60 feet deep, no coal	....	....	....	....	.. ..	E?	....	....
13	Center	S½	Drift mine, local, coal No. 5, dip is N. 1°-3°	....	Est.	....	Out-crop	.. ..	4 4	....	405
14	NE	SE	Drift mine, local, abd., coal No. 5	....	....	....	....	.. ..	.. ..	....	400±
14	NW	SE	Farm well	430	Est.	....	65	.. ..	6?	....	365
14	NE	NW	Drift mine, local, abd., coal No. 6, outcrop of sandstone	....	....	....	....	.. ..	.. ..	....	425±
15	NE	SE	Bridgett 1, coal test	375	Est.	91	c	c	c	284	....
15	SW	NE	Saline County Coal Corp. 177, coal test	379	?	121	....	4 8	.. ..	258	....
15	SW	SW	Farm well, 28 feet to cap rock	377	Est.	28±	....	.. ..	.. ..	....	....
15	SW	SW	Farm well	380	Est.	25	....	.. ..	.. ..	355	....

Abbreviations: Est., estimated; c, confidential; E., eroded; NDE, not deep enough; abd., abandoned.

TABLE 2.—*Field data*—continued

Location Township Sec.	 ¼	 ¼	Company and Description	Altitude of surface	Elevation [illegible]	Depth to coal No. 6	 No. 5	Thickness of coal No. 6		 No. 5		Altitude of coal No. 6	 No. 5
				Feet		*Feet*	*Feet*	*Feet*	*In.*	*Feet*	*In.*	*Feet*	*Feet*
SALINE COUNTY													
Cottage Grove													
T. 9 S., R. 7 E.													
17	SE	SE	[illegible] 4, coal test	375	Est.	40	152	c		c		335	223
17	SE	SW	Whoolery 11, coal test	395	Barometer	51	168	c		c		344	227
18	SW	SE	O'Gara 6, coal test	372	Level	69	194	c		c		303	178
18	SE	SE	Farm well	385	Est.	25	....	4	5	..	..	360	....
19	SW	NE	Farm well	410	Est.	22	....	4	6	..	..	388	....
19	SW	NE	Farm well, on hill	405	Est.	22	....	4	5	..	..	383	....
19	NW	SE	O'Gara 19, coal test	374	Level	....	[illegible]	..	..	c		....	[illegible]
19	SW	SW	O'Gara 18, may not be No. 5	356	Level	....	103	..	..	1	..	....	....
20	SW	NW	Drift mine, local, abd.	400?	Est.	Outcrop	....	..	..	..	..	....	....
20	SW	SW	O'Gara 22, coal test	380	....	....	85	..	..	c		....	295
20	NW	SE	O'Gara 20, coal test	376	....	....	83	..	..	c		....	293
20	SW	NE	Farm well	....	....	....	NDE	E		..	..	....	....
20	SW	NE	Farm well, coal reported	....	....	Less than 30	....	4 ?	6	..	..	....	....
20	NW	NE	Farm well, 23 feet deep, no coal	....	....	....	....	..	..	..	..	....	....
21	NW	SW	O'Gara 23, coal test	376	?	....	90	..	..	c		....	286
21	NE	NW	O'Gara 24, coal test	372	?	....	119	..	..	c		....	253

21	SE	NE	Coal test	370	Est.	....	86	..	..	..	..	....	284
22	NE	NE	Farm well, weathered coal surface	410	Est.	No. 6? outcrop	....	..	..	..	..	410	....
22	SW	NE	Cottage Oil Company, oil test	370-380	Est.	....	110	..	..	..	..	....	....
22	NW	SE	Drift mine, local, coal No. 6	....	....	Outcrop	....	..	..	..	..	....	....
22	SE	SE	Drift mine, local, coal No. 5a	....	....	....	....	..	..	..	..	....	....
23	NW	NW	School District, water well, 40-50 feet deep, no coal	....	....	....	....	..	..	..	..	....	....
23	SW	SE	Drift mine, local	....	....	Outcrop	....	..	..	..	..	....	....
23	SW	SE	Drift mine, local	....	....	Outcrop	....	..	..	..	..	....	....
24	NE	NE	Drift mine, local	....	....	Outcrop	....	..	..	..	..	....	....
27	NW	NW	O'Gara, 4 feet coal No. 5 (?) at 116 feet	....	....	....	....	..	..	..	..	....	....
27	NW	NW	O'Gara, 3 inches coal at 112 feet	....	....	....	....	..	..	..	..	....	....
Harrisburg T. 9 S., R. 6 E.													
1	NE	SE	Coal test	370	Est.	203	324	5	1	4	8	167	46
12	SE	NW	O'Gara	360	Level	227	348	6	6	4	7	133	12
12	SE	SE	O'Gara	360	Est.	157	273	2	9	4	9	203	87
13	NW	SW	O'Gara	350	Level	87	209	5	..	5	8	263	141

Abbreviations: Est., estimated; c. confidential; E., eroded; NDE, not deep enough; abd., abandoned.

TABLE 2.—*Field data*—concluded

Location Township Sec.	¼	¼	Company and Description	Altitude of surface	Elevation method	Depth to coal		Thickness of coal				Altitude of coal	
						No. 6	No. 5	No. 6		No. 5		No. 6	No. 5
				Feet		*Feet*	*Feet*	*Feet*	*In.*	*Feet*	*In.*	*Feet*	*Feet*
SALINE COUNTY													
Harrisburg													
T. 9 S., R. 6 E.													
13	SW	SE	O'Gara	357	Level	....	196	E		4	10	....	161
24	SW	NW	O'Gara	360	Level	....	135	E		2	2	....	225
24	SW	NE	O'Gara	358	Level	....	134	E		4	11	....	224
25	NW	NE	O'Gara	355	Level	....	....	E		E		....	....

Abbreviations: Est., estimated, c, confidential: E., eroded; NDE, not deep enough; abd., abandoned.

PUBLICATIONS

ILLINOIS MINING INVESTIGATIONS

Illinois State Geological Survey Division
Urbana, Illinois

Bulletin 1. Preliminary report on organization and method of investigations, 1913.
Bulletin 3. Chemical study of Illinois coals, by S. W. Parr, 1916.
Bulletin 10. Coal resources of District I (Longwall), by G. H. Cady, 1915.
Bulletin 11. Coal resources of District VII, by Fred H. Kay, 1915.
Bulletin 14. Coal resources of District VIII (Danville), by Fred H. Kay and K. D. White, 1915.
Bulletin 15. Coal resources of District VI, by G. H. Cady, 1916.
Bulletin 16. Coal resources of District II (Jackson Co.), by G. H. Cady, 1917.
Bulletin 17. Surface subsidence in Illinois resulting from coal mining, by Lewis E. Young, 1916.
Bulletin 18. Tests on clay materials available in Illinois coal mines, by R. T. Stull and R. K. Hursh, 1917.
Bulletin 19. Coal resources of District V, by G. H. Cady, 1919.
Bulletin 20. Carbonization of Illinois coals in inclined gas retorts, by F. K. Ovitz, 1918.
Bulletin 21. The manufacture of retort coal-gas in the central states, using low-sulphur coal from Illinois, Indiana, and western Kentucky, by W. A. Dunkley and W. W. Odell, 1918.
Bulletin 22. Water-gas manufacture with central district bituminous coals as generator fuel, by W. W. Odell and W. A. Dunkley, 1918.
Bulletin 23. Mines producing low-sulphur coal in the central district, by G. H. Cady, 1919.
Bulletin 24. Water-gas operating methods with central district bituminous coals as generator fuel. A summary of experiments on a commercial scale, by W. A. Dunkley and W. W. Odell, 1919.
Bulletin 25. Gas purification in the medium-size gas plants of Illinois, by W. A. Dunkley and C. E. Barnes, 1920.
Bulletin 26. Coal resources of District IV, by G. H. Cady, 1921.
Bulletin 27A. Analyses of Illinois coals, compiled by G. W. Hawley, 1923.
Bulletin 28. Preliminary report on coal stripping possibilities in Illinois, by Harold E. Culver, 1925.
Bulletin 29. Coal resources of District III, by Harold E. Culver, 1925.
Bulletin 30. Coal losses in Illinois, by C. A. Allen, 1925.
Bulletin 31. Coal stripping possibilities in southern and southwestern Illinois, by G. H. Cady, 1927.
Bulletin 32. Coal stripping possibilities in Saline and Gallatin counties near Equality, by L. G. Henbest, 1929.

Engineering Experiment Station
Urbana, Illinois

Bulletin 2. Coal mining practice in District VIII (Danville), by S. O. Andros, 1913.
Bulletin 4. Coal mining practice in District VII, by S. O. Andros, 1914.
Bulletin 5. Coal mining practice in District I (Longwall), by S. O. Andros, 1914.
Bulletin 6. Coal mining practice in District V, by S. O. Andros, 1914.
Bulletin 7. Coal mining practice in District II, by S. O. Andros, 1914.
Bulletin 8. Coal mining practice in District VI, by S. O. Andros, 1914.
Bulletin 9. Coal mining practice in District III, by S. O. Andros, 1915.
Bulletin 12. Coal mining practice in District IV, by S. O. Andros, 1915.
Bulletin 13. Coal mining in Illinois, by S. O. Andros, 1915. (Complete resumé of all the district reports.)
Bulletin 91. Subsidence resulting from mining, by L. E. Young and H. H. Stoek, 1916.
Bulletin 100. Percentage of extraction of bituminous coal with special reference to Illinois conditions, by C. M. Young, 1917.
Bulletin 113. Panel system of coal mining, by C. M. Young, 1919.
Bulletin 119. Some conditions affecting the usefulness of iron oxide for city gas purification, by W. A. Dunkley, 1921.
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Bulletin 132. A study of coal mine haulage in Illinois, by H. H. Stoek, J. R. Fleming and A. J. Hoskin, 1922.
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Bulletin 151. A study of skip hoisting in Illinois coal mines, by A. J. Hoskin, 1925.
Bulletin 158. Measurement of air quantities and energy losses in mine entries, Part I, by A. C. Callen and C. M. Smith, 1926.
Bulletin 170. Measurement of air quantities and energy losses in mine entries, Part II, by A. C. Callen and C. M. Smith, 1927.
Bulletin 184. Measurement of air quantities and energy losses in mine entries, Part III, by A. C. Callen and C. M. Smith, 1928.

U. S. Bureau of Mines
Washington, D. C.

Bulletin 72. Occurrence of explosive gases in coal mines, by N. H. Darton, 1915.
Bulletin 83. The humidity of mine air, by R. Y. Williams, 1914.
Bulletin 99. Mine ventilation stoppings, by R. Y. Williams, 1915.
Bulletin 102. The inflammability of Illinois coal dusts, by J. K. Clement and L. A. Scholl, Jr., 1916.
Bulletin 137. Use of permissible explosives in the coal mines of Illinois, by J. R. Fleming and J. W. Koster, 1917.
Bulletin 138. Coking of Illinois coals, by F. K. Ovitz, 1917.
Bulletin 203. Central district bituminous coals as water-gas generator fuel, by W. W. Odell and W. A. Dunkley, 1924.
Bulletin 234. The screen sizing of coal, ores and other minerals, by E. A. Holbrook and Thomas Fraser, 1924.
Bulletin 238. Subsidence due to coal mining in Illinois, by C. A. Herbert and J. J. Rutledge, 1927.
Technical Paper 190. Methane accumulations from interrupted ventilation, with special reference to coal mines in Illinois and Indiana, by H. I. Smith and Robert J. Hamon, 1918.
Technical Paper 246. Water-gas apparatus and the use of central district coal as generator fuel, by William W. Odell, 1921.
Technical Paper 268. Preparation and uses of tar and its simple crude derivatives, by W. W. Odell, 1922.
Technical Paper 284. Coal and coke mixtures as water-gas generator fuel, by W. W. Odell, 1921.
Technical Paper 304. Water-gas tar emulsions, by W. W. Odell, 1923.
Technical Paper 326. Fires in steamship bunker and cargo coal, by H. H. Stoek, 1923.
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